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ANNUAL REPORTS

OF VARIOUS

PUBLIC OFFICERS AND INSTITUTIONS

FOR THE YEAR

1910.

PUBLISHED BY THE SECRETARY OF THE COMMONWEALTH.

VOL. IV.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1911.

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Public Document **No. 34**

FORTY-SECOND ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1911.

APPROVED BY
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GENERAL REPORT.

In accordance with the provisions of chapter 211 of the Acts of 1905, the following report of the work of the several departments of the State Board of Health is presented for the fiscal year ended Nov. 30, 1910, on which date the Board was constituted as follows: —

HENRY P. WALCOTT, M.D., of Cambridge, *Chairman.*
HIRAM F. MILLS, A.M., C.E., of Lowell.
ROBERT W. LOVETT, M.D., of Boston.
GERARD C. TOBEY, Esq., of Wareham.
JAMES W. HULL of Pittsfield.
Hon. CHARLES H. PORTER of Quincy.
JULIAN A. MEAD, M.D., of Watertown.

On April 13, 1910, the Legislature passed the following act relative to the sale of cocaine, representing practically a codification of the previously existing laws concerning cocaine, with additions suggested by the experience of other States. The bill represented efforts made in conference between the secretary of the Board, representatives of the wholesale and retail druggists and a representative of the Watch and Ward Society. Under this law a large number of prosecutions have been brought, especially by agents of the Watch and Ward Society. There is every reason to believe that the law has been very much strengthened and that the unlawful sale of cocaine has been considerably decreased.

ACTS OF 1910, CHAPTER 387.

AN ACT RELATIVE TO THE SALE OF COCAINE.

Be it enacted, etc., as follows:

SECTION 1. It shall be unlawful for any person, firm or corporation to manufacture any so-called catarrh powder or catarrh cure, or any patent or proprietary preparation containing cocaine, or any of its salts, or alpha or beta eucaine, or any of their salts, or any synthetic substitute for them.

SECTION 2. It shall be unlawful for any person, firm or corporation to sell or to expose or offer for sale or to give, deliver or exchange any cocaine, or any alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof, except upon the written prescription of a physician, dentist or veterinary surgeon registered under the laws of the state in which he resides; the original of which prescription shall be retained by the druggist filling the same for a period of at least two years and shall not again be filled, except upon the written order of the original prescriber, and shall at all times be open to inspection by the officers of the state board of health, the members of the state board of registration in pharmacy and its authorized agents, and by the police authorities and officers of cities and towns. But no practitioner of veterinary medicine shall prescribe any of the above mentioned substances for the use of any human being.

SECTION 3. It shall be unlawful for any physician or dentist to prescribe, sell or give away any cocaine or its salts, or any alpha or beta eucaine or their salts, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof, to any person known to such physician or dentist to be an habitual user of those drugs.

SECTION 4. Any manufacturer or jobber of any or all of the articles mentioned in section two of this act, any wholesale druggist, or any registered pharmacist may sell any article mentioned in said section two to any such manufacturer, jobber, wholesale druggist, or to any pharmacist, physician, veterinarian or dentist, registered under the laws of the state in which he resides, or to any incorporated hospital, but only upon a written order duly signed by such manufacturer, jobber, wholesale druggist, registered pharmacist, registered physician, registered veterinarian, registered dentist, or the superintendent of such incorporated hospital, which order shall show the article or articles ordered and the date of delivery. The said order shall be kept on file in the laboratory, warehouse, pharmacy or store from which it was filled by the proprietor thereof, or his successor, for a period of not less than two years from the date of delivery, and shall at all times be open to inspection by the officers of the state board of health, the members of the state board of registration in pharmacy and its authorized agents, and by the police authorities and officers of cities and towns; and such order shall not contain any articles not mentioned in section two of this act.

SECTION 5. Whoever violates any provision of the foregoing sections shall be punished by a fine of not less than fifty nor more than one thousand dollars, or by imprisonment for not more than one year in a county jail or house of correction, or by both such fine and imprisonment.

SECTION 6. Whoever, not being a registered physician, registered dentist, or registered veterinary surgeon, or manufacturer or wholesale or retail dealer in drugs shall have in his or her possession any cocaine, alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof, except by reason of a prescription of a registered physician, registered dentist or registered veterinary surgeon, shall be guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine of not more than one hundred dollars or by imprisonment of not more than six months, or by both such fine and imprisonment. The provisions of this section shall not apply to any person, firm or corporation while transporting any of the above mentioned articles from or to any manufacturer or jobber, wholesale druggist, registered pharmacist, registered physician, registered veterinarian, registered dentist or incorporated hospital or to persons who may have the above mentioned articles in their possession in connection with the enforcement of the provisions of this act or with the trial of cases arising thereunder.

SECTION 7. If a person makes complaint under oath to a police, district or municipal court, or to a trial justice or justice of the peace authorized to issue warrants in criminal cases, that he has reason to believe or does believe that cocaine or alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof are kept or deposited by a person named therein in a store, shop, warehouse, building, vehicle, steamboat, vessel or place, other than by a manufacturer or jobber, wholesale druggist, registered pharmacist, registered physician, registered veterinarian, registered dentist, employees of incorporated hospitals or those who are entitled by law to have possession of any of the above mentioned articles, such court or justice, if it appears that there is probable cause to believe that said complaint is true, shall issue a search warrant to a sheriff, deputy sheriff, city marshal, chief of police, deputy marshal, police officer or constable commanding him to search the premises in which it is alleged that such cocaine, alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof are kept or deposited, and to seize such cocaine, alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof and securely keep the same until final action, and to arrest the person or persons in whose possession it is found, together with all persons present, and to return the warrant with his doings thereon as soon as may be to a court or trial justice having jurisdiction in the place in which such cocaine, alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof are alleged to be kept or deposited.

SECTION 8. If, after such notice as the court or trial justice shall order, it appears that the cocaine, alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof, seized according to the provisions of section seven of this act, was, at the time of making the complaint, in the possession of the person alleged therein in violation of law, the court or trial justice shall render judgment that such and so much of the cocaine, alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof, so seized as was so unlawfully kept, shall be forfeited to the commonwealth, and shall, by the authority of the written order of the court or trial justice, be forwarded by common carrier to the state board of health, which upon receipt of the same, shall notify said court or justice thereof. The said board shall sell the same, and after paying the cost of the transportation of the said cocaine, alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof, it shall pay over the net proceeds to the treasurer and receiver general.

SECTION 9. It shall be the duty of the state board of health to cause the prosecution of all persons violating the provisions of this act, but no prosecutions shall be brought against any wholesale or retail druggist for the sale or for the gift or the exchange of any patent or proprietary preparation containing cocaine or alpha or beta eucaine, or any synthetic substitute for them, unless the said board has, prior to such sale, gift or exchange, given public notice in some trade journal that the gift, sale or exchange of the said patent or proprietary preparations, naming them, would be contrary to law.

SECTION 10. The repeal of a law by this act shall not affect any action, suit or prosecution pending at the time of the repeal for an offence committed or for the recovery of a penalty or forfeiture incurred under any of the laws repealed.

SECTION 11. Section three and section five of chapter three hundred and eighty-six of the acts of the year nineteen hundred and six, and section four of the same chapter, as amended by section two of chapter three hundred and seventy-five of the acts of the year nineteen hundred and nine, and chapter three hundred and seven of the acts of the year nineteen hundred and eight, as amended in section two by section one of chapter three hundred and seventy-five of the acts of the year nineteen hundred and nine, are hereby repealed. [*Approved April 13, 1910.*

On April 22, 1910, the Legislature passed the following act relative to the common drinking cup: —

ACTS OF 1910, CHAPTER 428.

AN ACT TO RESTRICT THE USE OF COMMON DRINKING CUPS.

Be it enacted, etc., as follows:

SECTION 1. In order to prevent the spread of communicable diseases, the state board of health is hereby authorized to prohibit in such public places, vehicles or buildings as it may designate the providing of a common drinking cup, and the board may establish rules and regulations for this purpose.

SECTION 2. Whoever violates the provisions of this act, or any rule or regulation of the state board of health made under authority hereof shall be deemed guilty of a misdemeanor and be liable to a fine not exceeding twenty-five dollars for each offence.

SECTION 3. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 4. This act shall take effect on the first day of October, nineteen hundred and ten. [*Approved April 22, 1910.*

As required by this act, the Board, at a meeting held on July 21, 1910, made the following regulations concerning the furnishing of a common drinking cup: —

On and after Oct. 1, 1910, it shall be unlawful to provide a common drinking cup: —

(*a*) In any public park, street or way.

(*b*) In any building or premises used as a public institution, hotel, theatre, public hall or public school.

(*c*) In any railroad station, railroad car, steam or ferry boat.

The regulations were published throughout the State, through the agency of the associated press, on July 26, 1910, and there is every reason to believe that the law, together with the regulations made under it by the Board, is being very generally enforced.

On June 15, 1910, the Legislature passed the following act relative to the liability of producers of milk: —

ACTS OF 1910, CHAPTER 641.

AN ACT RELATIVE TO THE LIABILITY OF PRODUCERS OF MILK.

Be it enacted, etc., as follows:

SECTION 1. Section sixty-two of chapter fifty-six of the Revised Laws is hereby amended by adding at the end thereof the words: — nor unless he shall fail to bring the milk produced by him to the legal standard for milk solids and milk fat within twenty days after written notice has been sent from the officer taking said sample that it is below said standard. At any time after the said period of twenty days allowed the producer to bring his milk to the legal standard has elapsed the officer taking the first sample may take a second sample, and if it shall be found to be below the legal standard for milk solids and milk fat prosecution may follow, — so as to read as follows: — *Section 62.* A producer of milk shall not be liable to prosecution for the reason that the milk produced by him is not of good standard quality unless such milk was taken upon his premises or while in his possession or under his control by an inspector of milk, by a collector of samples of milk, or by an agent of the dairy bureau or of the state board of health, and a sealed sample thereof was given to him, nor unless he shall fail to bring the milk produced by him to the legal standard for milk solids and milk fat within twenty days after written notice has been sent from the officer taking said sample that it is below said standard. At any time after the said period of twenty days allowed the producer to bring his milk to the legal standard has elapsed the officer taking the first sample may take a second sample, and if it shall be found to be below the legal standard for milk solids and milk fat prosecution may follow.

SECTION 2. Section fifty-seven of said chapter fifty-six is hereby amended by striking out in the eighth line thereof the words "fifty dollars and", and inserting in place thereof the words: — not more than two hundred dollars or, — and by striking out in the eighth and ninth lines thereof the words "less than sixty nor." [*Approved June 15, 1910.*

Under this act 76 warnings have been sent out for the sale of milk below the legal standard, but, although 22 producers have been re-investigated subsequent to the twenty-day warnings, it has not been necessary to bring any prosecution up to the present time.

A defect in this law has been found in the last sentence of section 1, which states, "if it shall be found to be below the legal standard for milk solids *and* milk fat prosecution may follow." In section 56 of chapter 56, Revised Laws, defining what shall be considered standard milk, it is stated that "milk which, upon analysis, is shown to contain less than twelve and fifteen hundredths per cent. of milk solids *or* less than three and thirty-five hundredths per cent. of fat, shall not be considered of good standard quality."

The effect of the new law has been to make it necessary that, before prosecution can take place for the sale of substandard milk, said milk must be below the legal standard both for milk solids and for milk fat. It is therefore desirable that legislation be enacted at the coming session to remedy this defect in the law.

ACTS OF 1910, CHAPTER 394.

AN ACT RELATIVE TO THE POWERS OF THE FOOD AND DRUG INSPECTORS OF THE STATE BOARD OF HEALTH.

Be it enacted, etc., as follows:

Inspectors of the state board of health, appointed under the provisions of section five of chapter seventy-five of the Revised Laws, shall have, in respect to milk, the power and authority conferred upon milk inspectors of cities and towns. [*Approved April 13, 1910.*

ACTS OF 1910, CHAPTER 528.

AN ACT RELATIVE TO THE ADULTERATION OF FOOD PRODUCTS WITH CANE SUGAR AND THE LABELING OF CANNED GOODS OR DRIED FOOD PRODUCTS.

Be it enacted, etc., as follows:

SECTION 1. Subdivision eight of section eighteen of chapter seventy-five of the Revised Laws is hereby amended by striking out the word "but", in the thirtieth line of said section, and inserting in place thereof the words: — but this paragraph shall not be construed as permitting the use of cane sugar in maple syrup, maple sugar, honey, cocoa, or any other food product in which the presence of cane sugar as a preservative is unnecessary. Furthermore, — so as to read as follows: — 8. If it contains any added antiseptic or preservative substance, except common table salt, saltpetre, cane sugar, alcohol, vinegar, spices, or, in smoked food, the natural products of the smoking process; but this paragraph shall not be construed as permitting the use of cane sugar in maple syrup, maple sugar, honey, cocoa or any other food product in which the presence of cane sugar as a preservative is unnecessary. Furthermore, the provisions of this definition shall not apply to any such article if it bears a label on which the presence and the percentage of every such antiseptic or preservative substance are clearly indicated, nor shall it apply to such portions of suitable preservative substances as are used as a surface application for preserving dried fish or meat, or as exist in animal or vegetable tissues as a natural component thereof, but it shall apply to additional quantities. Said definition shall not apply during the year nineteen hundred and two to goods which were held in stock by retail dealers prior to the first day of January in said year. The provisions of this and the two preceding sections relative to food shall not apply to mixtures or compounds not injurious to health and which are recognized as ordinary articles or ingredients of articles of food, if every package sold or offered for sale is distinctly labeled as a mixture or compound with the name and per cent of each ingredient therein.

SECTION 2. Section twenty-three of said chapter seventy-five is hereby amended by striking out the words "maple syrup", in the fifth line, the word "or", in the sixth line, and the words "of the goods", in the eighth line, by inserting after the word "ingredients", in the eighth line, the word: — thereof, — so as to read as follows: — *Section 23.* All canned articles of food which have been prepared from dry products and have been soaked before canning shall be plainly marked by an adhesive label having on its face the word "*soaked*" in letters of legible type not smaller than two line pica. All cans, jugs and other packages containing molasses shall be plainly marked by an adhesive label having on its face the name and address of the person who made and prepared the same with the name and quality of the ingredients thereof in letters of the size and description aforesaid.

SECTION 3. This act shall take effect on the first day of April, nineteen hundred and eleven. [*Approved May 18, 1910.*

ACTS OF 1910, CHAPTER 416.

AN ACT RELATIVE TO PROSECUTIONS UNDER THE LAWS RELATIVE TO ADULTERATED DRUGS AND FOOD.

Be it enacted, etc., as follows:

SECTION 1. No prosecution shall be begun under sections sixteen to twenty-seven, inclusive, of chapter seventy-five of the Revised Laws, for the manufacture, sale or offering for sale of drugs, unless the person purchasing the drug or taking the drug without purchasing shall seal and deliver to the owner or person from whom such drug is purchased or taken a portion of the drug so purchased or taken; and a receipt therefor shall be given to the collector. The drug so purchased or taken shall thereafter be analyzed or tested under the direction of the state board of health for the purpose of determining whether it comes within the provisions of the sections above mentioned.

SECTION 2. If it appears that any provision of the said section has been violated, the said board may direct or authorize formal complaint to be made to a court or justice having jurisdiction in such cases; but no evidence of the result of said analysis or test shall be received if the collector refuses or neglects to seal and deliver a portion of the drug purchased or taken as aforesaid to the owner or person from whose possession it is taken. [*Approved April 20, 1910.*

On May 7, 1910, the Legislature passed the following act, requiring the State Board of Health to make analyses of drugs and poisons in certain cases: —

ACTS OF 1910, CHAPTER 495.

AN ACT TO REQUIRE THE STATE BOARD OF HEALTH TO MAKE ANALYSES OF DRUGS AND POISONS IN CERTAIN CASES.

Be it enacted, etc., as follows:

SECTION 1. The state board of health shall make, free of charge, a chemical analysis of cocaine, alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salt or compound thereof, and of any poison, drug, medicine or chemical, when submitted to it by police authorities or by such incorporated charitable organizations in the commonwealth, as the state board of health shall approve for this purpose: *provided,* that said board is satisfied that the analysis is to be used for the enforcement of law.

SECTION 2. The said board shall furnish a certificate of the result of the analysis above provided for to said authorities or organizations, and the certificate shall be prima facie evidence of the composition and quality of the materials so analyzed.

SECTION 3. This act shall take effect upon its passage. [*Approved May 7, 1910.*

As a result of the passage of this act the work of the food and drug department has been considerably increased, especially through the activities of the Watch and Ward Society in its crusade against the illegal sale of cocaine and morphine. This work necessarily takes away from the efficiency of the food and drug department in its investigations of the food and drug situation in other lines.

Furthermore, owing to the passage by the Legislature of chapter 311 of the Acts of the year 1910, forbidding food and drug inspectors to receive court fees, an additional expense of approximately $1,000 has been placed upon this department of the Board.

To cover these additional expenses it is recommended that an increased appropriation of $3,000 be made for the use of the food and drug department of the Board.

OPHTHALMIA NEONATORUM.

On April 27, 1910, the Legislature passed the following act for the prevention of ophthalmia neonatorum: —

ACTS OF 1910, CHAPTER 458.

AN ACT RELATIVE TO THE PREVENTION OF OPHTHALMIA NEONATORUM.

Be it enacted, etc., as follows:

SECTION 1. The state board of health shall furnish, free of cost, to physicians registered under the laws of the commonwealth such prophylactic remedy as it may deem best for the prevention of ophthalmia neonatorum.

SECTION 2. To carry out the provisions of this act there may be expending annually from the treasury of the commonwealth a sum not exceeding twenty-five hundred dollars. [*Approved April 27, 1910.*

In accordance with the requirements of this act the Board distributed to each registered physician in the Commonwealth an outfit for the prevention of ophthalmia neonatorum. This outfit consisted of a special dropper containing about 5 cubic centimeters of a 1 per cent. solution of nitrate of silver. This outfit has been received with general satisfaction throughout the State, and should be of great value in the prevention of blindness due to ophthalmia neonatorum.

Furthermore, in this campaign against ophthalmia neonatorum the Board has been able to accomplish results of considerable importance through its State Inspectors of Health. Whenever information comes to a State Inspector of Health that a case of ophthalmia neonatorum has occurred in any town in his district, it is his duty to investigate such a case immediately, to see that through the efforts of the attending physician or the local board of health such measures are taken as shall prevent the occurrence of blindness from this disease. It can be stated that this system, although in use but a short time, has, without doubt, prevented blindness in several instances.

TYPHOID FEVER.

At a meeting of the Massachusetts Association of Boards of Health, held on Oct. 27, 1910, a committee appointed to consider the subject of typhoid fever in the Commonwealth made the following recommendation: —

To recommend that the State Board of Health provide for the physicians and health officers of the Commonwealth bacteriological examinations of blood, urine and feces for the presence of typhoid bacillus.

This recommendation has been duly approved by the Board, and it therefore recommends that in order to carry out its provisions the appropriation for general expenses of the Board be increased by $1,500 annually.

INFANTILE PARALYSIS.

On April 21, 1910, the Legislature passed a resolve concerning infantile paralysis: —

RESOLVES OF 1910, CHAPTER 79.

RESOLVE TO PROVIDE FURTHER FOR AN INVESTIGATION BY THE STATE BOARD OF HEALTH OF INFANTILE PARALYSIS.

Resolved, That there be allowed and paid out of the treasury of the commonwealth the sum of five thousand dollars, to be expended under the direction of the state board of health in its investigation of the disease known as anterior poliomyelitis or infantile paralysis. [*Approved April 21, 1910.*

In pursuance of this resolve the Board has continued the investigation concerning this disease. The work was begun in 1907 and has increased annually in amount and importance. The report for 1909, the most elaborate yet produced, has been received with marks of unusual approbation, not only throughout the United States but also in foreign countries.

During 1910 the Board has utilized the services of two physicians, Dr. Philip Sheppard and Dr. Thomas P. Hennelly, in the investigation of this disease. Most of their attention has been devoted to the cities of Springfield and Fall River, where infantile paralysis has been especially prevalent. The reports of these investigators, together with information supplied by the practicing physicians throughout the State, have been compiled and appear in the Supplement. The interest in this disease has become world-wide, and the Board considers it of the greatest importance that its investigations for the coming year be very materially broadened in their scope. It therefore recommends that there be appropriated by the Legislature for the investigation of infantile paralysis in 1911 the sum of at least $10,000.

The reports upon the outbreaks of typhoid fever in North Adams, scarlet fever in Boston, and smallpox in Wakefield, Reading, Stoneham and Melrose will be found in the Supplement.

LAW RELATIVE TO INSPECTORS OF MILK.

ACTS OF 1910, CHAPTER 457.

AN ACT RELATIVE TO INSPECTORS OF MILK.

Be it enacted, etc., as follows:

SECTION 1. No person whose business is, in whole or in part, the buying or selling of milk, or who is an officer, agent or employee of any person, partnership or corporation engaged in the sale of milk shall hereafter be appointed or reappointed an inspector of milk.

SECTION 2. This act shall take effect upon its passage. [*Approved April 27, 1910.*

SALE OF MORPHINE AND OTHER NARCOTIC DRUGS.

ACTS OF 1910, CHAPTER 271.

AN ACT TO REGULATE THE SALE OF MORPHINE AND OTHER NARCOTIC DRUGS.

Be it enacted, etc., as follows:

SECTION 1. It shall be unlawful for any person to sell, furnish, give away or deliver any opium, morphine, heroin, codeine or preparations thereof, or any salt or compound of the said substances, except upon the written prescription or order of a lawfully authorized practitioner of medicine, dentistry, or veterinary medicine, which prescription shall bear the name of the person giving it. But the provisions of this section shall not apply to sales made by any manufacturer, wholesale or retail druggist to another manufacturer, wholesale or retail druggist; nor to sales made to hospitals, colleges, scientific or public institutions, or to physicians, dentists, or veterinary surgeons; nor to the sale of cough remedies and other domestic and proprietary preparations: *provided,* that such preparations are sold in good faith as medicines, and not for the purpose of evading the provisions of this act; and *provided,* that such preparations do not contain more than two and one half grains of opium, or one third of a grain of morphine, or one fourth of a grain of heroin, or one grain of codeine or their salts in one fluid ounce; or if a solid preparation, in one avoirdupois ounce, excepting liniments and ointments which are prepared for external use only; nor to preparations containing opium or any of its salts, which are sold in good faith, for diarrhœa, cholera or neuralgia; nor to powder of ipecac and opium, commonly known as Dover's powders; nor to compound medicinal tablets, pills, or powders containing not over one twentieth of a grain of morphine, or one twelfth of a grain of heroin or one fourth of a grain of codeine, or any of their salts to each pill, powder or tablet, *provided,* that such preparations are sold in good faith as medicines and not for the purpose of evading the provisions of this act.

SECTION 2. It shall be unlawful for any practitioner of medicine, dentistry, or veterinary medicine to prescribe for the use of any habitual user of the same, opium, morphine, heroin, codeine, or any salt or compound of the said substances, or any preparation containing any of the said substances or their salts or compounds; nor shall any practitioner of dentistry prescribe any of the said substances for any person not under his treatment in the regular practice of his profession; nor shall any practitioner of veterinary medicines prescribe any of the said substances for the use of any human being: *provided, however,* that the provisions of this section shall not be construed to prevent any lawfully authorized practitioner of medicine from prescribing in good faith for the use of any habitual user of narcotic drugs who is under his professional care such substances as he may deem necessary for his treatment, when such prescriptions are given in good faith and not for the purpose of evading the provisions of this act.

SECTION 3. Whoever violates any provision of this act shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not less than five dollars nor more than one thousand dollars; or shall be imprisoned in the house of correction or jail for a term not exceeding one year; or shall be punished by both such fine and imprisonment. [*Approved March 22, 1910.*

WATER SUPPLY AND SEWERAGE.

The State Board of Health presents herewith a report of its doings for the twelve months ended Nov. 30, 1910, under the provisions of laws relating to the protection of the purity of inland waters, as required by chapter 75, section 115, of the Revised Laws.

The Board has received during the year 139 applications for advice with reference to water supply, sewerage, sewage disposal and matters relating thereto, — a larger number than in any previous year. Of these applications, 96 were in relation to water supply, 8 to sources of ice supply, 26 to sewerage, drainage and sewage disposal, 4 to pollution of streams, and 5 to miscellaneous matters.

WATER SUPPLIES.

Public water supplies were introduced during the year in the towns of Douglas, Dudley and Granville, and additions and improvements were made in many of the existing systems. Of the 354 cities and towns in the State, 192, containing by the census of 1910 a population of 3,171,055, are provided with public water supplies. The remaining towns — 162 in number — contained by the census of 1910 a population of 195,361. These towns are practically all of small size, there being only 7, viz., Barnstable, Blackstone, Dartmouth, Sutton, Templeton, Tewksbury and Warren, which have a population in excess of 3,000. Of the 86 towns having, by the census of 1910, a population of less than 1,000, only 4 have public water supplies. Of the 83 towns having a population of between 1,000 and 2,000, 28, or about one-third, have public water supplies; while of the 47 towns having between 2,000 and 3,000 population, 29, or nearly two-thirds, have public water supplies.

Water works systems in Massachusetts are in a large majority of cases owned by the municipality, or by a fire or water supply district. Of the 192 cities and towns having public water supplies, 151 are supplied wholly or in part from municipal or district works, while 41 are supplied by water companies. There are more than 41 water companies in the State, however, since in a few cities and towns having municipal works a village or district is supplied by a water company; for example, in the town of Wareham the main portion of the town is supplied by the Wareham Fire District, while the summer resort known as Onset is supplied by a water company. Of the 41 towns supplied wholly by water companies, 22 have a population of less than 3,000, while only 6 have a population in excess of 7,000.

DEFICIENCY IN RAINFALL AND ITS EFFECT UPON PUBLIC WATER SUPPLIES.

The year 1910 has been marked by a decided deficiency in rainfall, which, on account of the fact that it has followed several years of less than average precipitation, has probably been more seriously felt than the years of low rainfall that immediately preceded it. There has been a deficiency in rainfall, taking the State as a whole, in every year since 1903. The deficiency was very slight in 1907, though during the first eight months of that year, — up to the end of August, — the precipitation was less than in a similar period for many years. In the years 1904 and 1906 the deficiency was not very serious. In the year 1909 the rainfall in the State as a whole was but little below the normal, but was very unequally distributed, being in excess of the normal in the eastern and southeastern portions and much less than the normal in the western parts of the State. The years of greatest drought were 1905 and 1908, in each of which the deficiency was about 7½ inches, and 1910, when it has probably amounted to as much as 9 inches.

The drought of this year has probably been more severe than any since the year 1883. The deficiency of rainfall has not affected materially the great storage reservoirs of the metropolitan water works system, which supplies water to 18 cities and towns in the metropolitan district, containing about one-third of the population of the State supplied with water from public works; but it has affected greatly the supplies of more than 50 cities and towns outside of the metropolitan district, or one-third or more of the cities and towns having public water supplies, including many of the larger cities of the State. In some places it has been necessary to supplement the public water supply with water taken from the nearest available stream or reservoir, the waters of some of which have been found to be of inferior or suspicious quality. In some cases, however, the necessity for introducing temporary supplies has been avoided by restrictions upon the use of water from the public works. These restrictions have in some cases caused considerable annoyance, but as a rule the inhabitants of cities and towns supplied from municipal water works systems were put to little inconvenience as compared with the inhabitants of villages and districts where no public water supply is available, in many of which the scarcity of water for domestic purposes has caused great hardship.

SANITARY PROTECTION OF SOURCES OF WATER SUPPLY.

In the year 1908 the Legislature enacted a statute entitled "An Act to provide for the protection of sources of water supply," authorizing cities, towns and fire districts duly established by legislative authority to take lands and certain other property under certain conditions, to preserve the purity of their water supplies. This act does not include the "water districts," so called, a number of which have been established by legislative authority in recent years. One of these districts recently made application to the Board, under the statute, for authority to purchase certain areas of land for the protection of its water supply, but it was found that the statute was not broad enough to authorize action by the water district, though in this case the district now includes all of the populous areas of a large town.

There appears to be no reason why the water districts should not be admitted to the same privileges as the fire districts. This could be done by amending section 1 of chapter 499 of the Acts of 1908 by inserting after the word "towns" in the first line the words "water districts," so that section 1 would read as follows: —

> SECTION 1. Cities, towns, water districts and fire districts duly established by legislative authority may, with the consent and approval of the state board of health, given after due notice and a hearing, take, or acquire by purchase or otherwise, and hold any lands, buildings, rights of way and easements within the watershed of any pond, stream, reservoir, well or other water used by them as a source of water supply, which said board may deem necessary to protect and preserve the purity of the water supply.

RULES AND REGULATIONS FOR THE SANITARY PROTECTION OF PUBLIC WATER SUPPLIES.

Under the authority of chapter 75, section 113, of the Revised Laws, authorizing the State Board of Health to make rules and regulations for the sanitary protection of public water supplies, the Board during the year 1910 established rules and regulations for the sanitary protection of the water supplies of Braintree (Great Pond), Concord (Nagog Pond), Gardner (Crystal Lake and Perley Brook), Hudson (Gates Pond), Springfield (Westfield Little River), Stockbridge (Lake Averic) and Russell (Black Brook).

The cities and towns for the protection of the water supplies of which rules and regulations have been made and are now in force are the following: —

Abington and Rockland.
Amherst.
Andover.
Attleborough.
Braintree.
Brockton and Whitman.
Cambridge.
Chicopee.
Concord.
Danvers and Middleton.
Easthampton.
Fall River.
Falmouth.
Fitchburg.
Gardner.
Greenfield.
Haverhill.
Holyoke.
Hudson.
Lincoln and Concord.
Lynn.
Marlborough.
Maynard.
Montague.
Northampton.
Northborough.
Norwood.
Peabody.
Pittsfield.
Plymouth.
Randolph and Holbrook.
Rockport.
Russell.
Salem and Beverly.
Springfield.
Springfield and Ludlow.
Stockbridge.
Taunton.
Wakefield.
Westfield.
West Springfield.
Weymouth.
Winchester.
Worcester.

In addition to the above, the water supplies of the metropolitan water district, including 18 cities and towns, are also protected by such rules.

Water Supply of the City of Lynn.

On April 7, 1910, in response to a communication from the city of Lynn relative to the improvement of the water supply of that city, the Board advised as follows: —

> The State Board of Health received from you on Jan. 26, 1910, a communication stating that the city government of Lynn, on Jan. 24, 1910, approved and endorsed the recommendations of your Board relative to the treatment and purification of the public water supply of the city by the installation of a mechanical filtration system.
>
> Your report of Jan. 21, 1910, contains the following recommendations: —

With the distinct understanding that the best chemical-mechanical plant must for safety always be under the care of a competent expert, that daily analyses must be made of the water, the best safeguards and checks against unskilled handling provided, and our storage facilities utilized to their fullest extent, the following plan, combining long storage and purification by chemical-mechanical means, is now recommended. In this plan it is proposed to not only filter all of the water but to improve the storage conditions by the installation of pumps at Montrose, on the Saugus River, and at Hawkes Pond, discharging into the northern arm of Walden Pond, thus not only getting additional storage and the opportunity of taking water from Saugus River at any time, but making it impossible, in any practicable way, for water to reach the filters until it has been stored for a long time.

If this general plan is approved by the council and the State Board of Health, as required by the act, detailed plans will be prepared and submitted to the council and the State Board for final examination and approval, as the act also required.

Without plans of the work and method of treatment it is not practicable to make accurate statements of the results, but from experience and experiments made elsewhere it is probable that the cost of maintaining an efficient plant will be enough more than the cost of maintaining good slow sand filters to make the entire cost of construction and maintenance of the chemical-mechanical filters greater than that of the slow sand filters.

In the removal of color the chemical-mechanical filter has some advantage, but the result from either process with Lynn water would probably be entirely satisfactory. In the removal of disagreeable tastes and odors a chemical-mechanical filter would not be as efficient as a slow sand filter. With such tastes and odors as have been experienced during the past year the proposed process might be satisfactory; but the increasing amount of Saugus River water to be added to the reservoirs is likely to increase the growth of organisms which produce the disagreeable tastes and odors to such an extent that mechanical filters will not remove them.

The efficiency in removal of bacteria of the best chemical-mechanical filters is not as high or as steady as of the best slow sand filters.

Complaints are made of excessive corrosion of iron pipes and copper tanks in which is used filtered water from well-managed chemical-mechanical filters, which effect appears to be most serious with soft dark waters, like those of Lynn. This is thought to be due to the increase in carbonic acid in such waters, due to filtration with coagulants.

With these results we have reason to expect active corrosion of steam boilers and water containing so much iron rust as to be very objectionable for domestic use.

We find no such general improvement in the health of the community from using the best regulated mechanical filters as when good slow sand filters have been used.

While purification by chemical-mechanical filters remains in its present experimental condition, with very objectionable results unremoved, we are unable to advise its adoption by the city of Lynn.

Subsequently, on Oct. 6, 1910, plans for works for treating the water supply of the city of Lynn by chemical-mechanical filtration were submitted for action by the Board, under the provisions of chapter 658 of the Acts of the year 1910, and on Nov. 3, 1910, the Board replied to that application as follows: —

> The State Board of Health received on Oct. 6, 1910, plans and specifications of a mechanical filtration plant proposed for construction at Lynn, together with copies of the letters and communications of George W. Fuller, C.E., to the engineer and water board of the city of Lynn.
>
> These communications do not indicate that the engineer, Mr. Fuller, advised the officials of Lynn that a mechanical filter plant would best serve the city in rendering the water supply satisfactory, but that he presents "a statement containing the essential features of a mechanical filter plant, for which you instructed me to prepare plans and specifications in conformity with chapter 658 of the Acts of 1910."
>
> These plans as outlined present the usual type of mechanical filter plant as constructed at the present time, with modifications due to this location and with the addition of the recently discovered bleaching-powder treatment. They leave many details of construction apparently to the discretion of the contractor or the mechanical filter company successful in its bid for construction.
>
> The mode of construction of the apparatus for handling and filtration, by the method decided upon by the city of Lynn, of the public water supply of the city is of much less importance in the view of the Board at the present time than the probable quality of the effluent from said filtering plant.
>
> The Board concludes from its investigations and its experiments upon the Lynn water that the proposed treatment will probably fail to remove the objectionable tastes and odors arising in the Lynn water after Saugus River and Ipswich River waters are added. The proposed treatment is further likely to increase the growth of organisms in the open distributing reservoir, and there increase the disagreeable tastes and odors of the water distributed to consumers.
>
> The experiments of the Board with Lynn water, treated as proposed, indicate that chemical conditions will be introduced in the water supplied to consumers that will cause corrosion of metals or increase of hardness, or both, to an objectionable degree; and we find that waters treated as proposed do not cause the general improvement in the health of the community that has been experienced when good slow sand filters have been used.
>
> The treatment proposed here is an experiment like others that have been tried, but when made with water similar to that of Lynn we know of no cases where the result has been such that we could advise the city of Lynn to *depend* upon it for producing a satisfactory water supply.

EXAMINATION OF SEWER OUTLETS.

Under the provisions of chapter 75, section 4, of the Revised Laws, requiring the annual examination of all main outlets of sewers and drains in the cities and towns of the Commonwealth and the effect of sewage disposal, the sewer outlets of the various cities and towns have been examined and chemical analyses have been made of the effluents of sewage-disposal systems and of many of the waters into which the sewage is discharged.

The sewage of the city of Boston and of the north and south metropolitan sewerage districts is discharged into Boston harbor at three principal outlets, located, respectively, at Moon Island, Deer Island and Peddock's Island. At Moon Island the sewage of the main portion of the city of Boston, amounting ordinarily to about 80,000,000 gallons per day, is discharged in the second and third hours of each outgoing tide, being stored at other times in reservoirs provided for the purpose on Moon Island. There has been no very decided change in the quantity or character of the sewage discharged at this outlet, and the conditions about it remain about the same as in previous years.

The sewage of the north metropolitan district is discharged at the southeasterly end of Deer Island at all stages of the tide, and its quantity has increased gradually with the growth of the district since the works were established. The sewage is very rarely traceable by the thin oily film on the surface of the water for a distance of a mile from the outlet, and objectionable odors are confined to a limited area within a few hundred feet of it.

At Peddock's Island, where the sewage of the south metropolitan system has been discharged in rapidly increasing quantity since the works were completed, in 1904, the effect of the sewage is confined to the immediate vicinity of the outlet, and has very little effect upon the harbor water. This outlet is located at the bottom of the sea, where the water is 30 feet deep at low tide, and investigations during the past year indicate that the sewage is very quickly diluted by the sea water, so that at the surface of the sea just over the outlet the percentage of sewage in the water, as determined by chemical analysis, is very small. This outlet under ordinary conditions would be very difficult to locate were it not for the fact that, like the other outlets, it is a feeding ground for large numbers of gulls.

A comparative study of these outlets indicates that the discharge of sewage near the bottom of the sea in deep water, especially where there is a considerable current, aids very greatly in its rapid dilution and in the prevention of objectionable odors.

Aside from the city of Boston and the metropolitan districts there are 14 cities and towns in the State which dispose of their sewage by discharge into the sea. At New Bedford about two-thirds of the sewage of the city is discharged into New Bedford harbor at numerous outlets, while the remaining portion flows into Clark's Cove through several main outlets near the head of the cove. The conditions at the head of Clark's Cove are very offensive, and on account of the fact that the district about it is densely populated, the nuisance is a serious one to large numbers of people. The outlets into the harbor are also in most cases serious nuisances. During the year the city has made rapid progress in its investigations as to an improved system of sewage disposal, and in the latter part of the year submitted to the Board a plan which provides for collecting the dry-weather flow of sewage of the city and discharging it at an outlet into the sea about 3,000 feet southeast of Clark's Point. The proposed outlet is located at a point where the water is 30 feet deep, in a tidal channel of large volume, where the sewage will be quickly diffused in the water, the conditions being quite similar in many respects to those at the Peddock's Island outlet in Boston harbor. Until the completion of these works there is no practicable way of relieving the nuisances caused by the discharge of sewage into New Bedford harbor and Clark's Cove.

The sewage of the city of Fall River is discharged at various outlets into the Taunton River opposite the city. A few of these outlets are objectionable on account of the fact that the sewage is discharged into open channels at a considerable distance from the shore, and the odor from these open sewer outlets is offensive in their neighborhood. In most cases the sewage is discharged at the shore and does not diffuse quickly with the water, but moves slowly along in the lesser currents on the edge of the stream, and creates objectionable conditions along the shore. It is probable that these conditions could be greatly improved by carrying the sewer outlets into deeper water well away from the shore, where the sewage may quickly become diffused in a large body of water.

The sewage of the city of Salem and town of Peabody is discharged into Salem harbor at Great Haste Island, about a mile and a quarter east of Winter Island and about midway between the Marblehead and Beverly shores. The sewage of these municipalities contains a very large quantity of manufacturing waste, especially waste liquids from sheepskin and other tanneries, and the quantity of this kind of waste is large in proportion to the population connected with the sewers. The outlet is located near the surface of the sea at low tide, and the sewage spreads to long distances from the outlet before becoming diluted and thoroughly diffused in the sea water. In consequence, an offensive odor is noticeable, sometimes over a wide area in the neighborhood of this outlet. To prevent these objectionable conditions it will probably be necessary to extend this outlet to deeper water, where the sewage will be more quickly and efficiently diluted than is practicable with an outlet located near the surface of the sea, where the tidal currents are slow and weak, as is the case in the neighborhood of this outlet.

The sewage of Beverly is discharged into Beverly harbor near the edge of the channel off Andrews Court, close to a populous shore, a part of which, at no great distance from the outlet, is used as a city playground. The city has grown rapidly in recent years, increasing the quantity of sewage discharged at this main outlet, and lately some of the sewage from the easterly part of the city has been conveyed temporarily to the Andrews Court outlet, pending the selection of a plan for the satisfactory disposal of the sewage. A plan was submitted to the Board on Dec. 15, 1908, providing for collecting the sewage from the various parts of the city, by means of a system of sewers, pumping stations and force-mains, into two main sewers discharging at an outlet north of Great Haste Island in Salem harbor. The Board gave a hearing on this question some time ago, but the matter was postponed, awaiting the results of further investigations by the city relative to a general system of sewage disposal. The conditions about the present main outlet near Andrews Court are objectionable. The quantity of sewage discharged here is much greater than formerly and seriously pollutes the waters along the adjacent shores, which are the resort of large numbers of people in the summer season.

There are very objectionable conditions about the outlet of the Lynn sewage, which is discharged into a small arm of the harbor channel, whence it spreads over a wide area of adjacent flats, where the sludge, decomposing, produces a serious nuisance.

The sewer outlet at Newburyport and the effect of the sewage discharged there is being investigated in connection with the condition of the Merrimack River.

At the remaining outlets from which sewage is discharged into the sea the conditions remain about the same as in previous years.

Up to the present time 64 of the inland cities and towns of the State have provided themselves with systems of sewerage. Of these cities and towns, 14, including most of the larger cities having sewer outlets into inland waters, are located on the two largest rivers, — the Connecticut and Merrimack, — and in practically all these cases the sewage is discharged directly into the streams without treatment. Of the remaining 50 cities and towns situated on the smaller streams 27 have constructed works for purifying the sewage or subjecting it before discharge to some form of treatment for the removal of organic matters. In the remaining 23 cities and towns the sewage is discharged into the streams without any form of treatment, but in 5 of these works for purifying the sewage or removing some of the organic matter therefrom before discharge are now under construction.

The sewer outlets of these cities and towns have been examined and their condition noted, but in most cases the most important effect of the discharge of the sewage into the rivers of the State is the effect of such discharge upon the general condition of the stream rather than the conditions immediately about the sewer outlets. In most cases sewer outlets discharging into the smaller rivers are located at the edge of the stream, and at times, especially during periods of low flow, the sewage does not mingle quickly with the water but is carried along near the bank, where there is frequently an accumulation of organic matter from the sewage, giving rise to an offensive odor. In some cases the sewage is discharged into a ravine or small waterway, whence it flows to the river through an open channel. These outlets are objectionable, and their condition could easily be remedied by extending a pipe large enough to convey the dry-weather sewage to deep water in the stream, leaving a considerable width of water between the bank and the outlet. Very satisfactory outlets of this kind have been constructed in some of the rivers, especially at some of the larger outlets in the city of Springfield.

POLLUTION OF STREAMS.

Assabet River.

The Assabet River has been one of the most seriously polluted rivers of the State, and in past years has been a nuisance at several points in its course, especially below the sewage filter beds at Westborough and Hudson, respectively, and below the town of Maynard, where it is grossly polluted by sewage and manufacturing wastes, chiefly those discharged from the woolen mills in that town. The nuisance below Westborough has been due to the inefficient purification of the sewage at the Westborough sewage filtration area, caused chiefly by the discharge into the sewers of manufacturing wastes from a yeast factory containing yeast and alcohol. The Board, acting under the provisions of chapter 433 of the Acts of the year 1909, requested action by the Attorney-General to prevent the discharge of these substances into the sewers in the town of Westborough, and in the latter part of the summer of 1910 the operation of the yeast factory was discontinued. Since that time the efficiency of the purification of the sewage at the Westborough filter beds has improved rapidly, and the condition of the river below the filter beds has also shown a marked improvement. With the increase in the size of the filtration area, which is now being made by the town, the filters will no doubt be capable of purifying the sewage satisfactorily in the future, provided manufacturing wastes of kinds which interfere with the operation of the works shall be kept out of the sewers.

At Hudson a similar difficulty in the operation of the filter beds was caused by the discharge of manufacturing wastes, chiefly wool-scouring liquors, from a woolen mill into the town sewers. The area of filter beds has been enlarged, and in the summer of 1909 the wool-scouring waste was diverted from the sewers to treatment works for the removal of the grease, which have been erected in the neighborhood of the mill. Upon the removal of this waste from the sewers the efficiency of the purification of the sewage at the filter beds has rapidly improved. The manufacturing wastes which were diverted from the sewers for treatment for the removal of wool grease have since then been discharged into the stream, the condition of which below the town of Hudson is more seriously polluted than last year.

At Maynard the American Woolen Company and the town of Maynard were notified by the Board late last year of the causes of the serious nuisance in the stream, and the necessity for purifying the sewage and manufacturing wastes in order to relieve this nuisance. During the past year the woolen company has been making investigations relative to the suitability of certain areas of land in the neighborhood of the village for the purification and disposal of the sewage and manufacturing wastes.

Blackstone River.

In its upper waters the Blackstone River is very badly polluted by wastes discharged from mills of various kinds, and immediately below some of these mills — especially in the town of Leicester and the upper part of the city of Worcester — the stream has in places been offensive during the past year. During the past two years chemical analyses have indicated a decided increase in the pollution of the stream before it reaches the Worcester sewage purification works. Below the purification works the condition of the river has shown no important changes except at Uxbridge, where there has been a considerable increase in the organic matter as compared with previous years.

Connecticut River.

The Connecticut River has not as yet shown any very marked effect of sewage pollution. There are sewer outlets into the stream at numerous points along its course, the uppermost being at Turners Falls near the northerly boundary of the State. The greatest quantity of sewage is discharged into the stream at Holyoke and at Springfield in the southerly portion of the State, but below Springfield, a short distance from the point where it enters the State of Connecticut, the water shows very little effect of pollution. In nearly all places where sewer outlets are located at the edge of the river, in slack water or where the current is sluggish, the conditions are objectionable, but in places where the outlets for the dry-weather flow of sewage have been carried well out into the stream, as in the case of many outlets at Springfield, the sewage becomes thoroughly mingled with the water and no evidence of it appears upon the banks. There are several objectionable outlets discharging near the bank of the river, one of the most offensive being on the West Springfield side, a short distance below the covered bridge at Springfield. The condition of the banks of the river could be materially improved if the dry-weather flow of sewage from all the sewer outlets were carried out into the stream, where it would mingle quickly with the water.

French River.

The French River, which is very badly polluted at several points along its course, and especially at Webster, where it receives a large quantity of waste from a woolen mill in addition to the sewage of the town, has shown an increase in the degree of pollution, as compared with previous years.

Green River.

The Green River, formerly badly polluted by the sewage of the town of Greenfield, has continued in much the same condition as in former years, but the town has begun the construction of a sewer for the removal of the sewage to a place of disposal near the point where the Green River joins the Deerfield River, and provision is being made in the proposed plan for removing a portion of the solids from the sewage by screening. With the completion of this work it will be practicable to prevent further nuisance in the Green River in the thickly populated parts of the town.

Hoosick River.

Investigations have been in progress during the year upon the disposal of the sewage of the city of North Adams, which now grossly pollutes the Hoosick River below that city, and plans have been made for works for the purification of the sewage of the town of Adams.

Housatonic River.

The branches of this stream in and about Pittsfield for the most part show improvement in their condition over earlier years, but below the city the river shows increasing evidence of pollution. Farther down stream its condition shows no material change from previous years.

Merrimack River.

This river receives considerable pollution from cities beyond the limits of the State, and a large amount of pollution by sewage and the wastes from manufacturing in the cities and towns along its banks in Massachusetts. Investigations have been carried on during the year to determine the quantity and character of the manufacturing waste discharged into the stream, the kinds and source of the waste matters which have the most serious effect in the pollution of the water and the means by which the effect of these waste matters can be removed. The manufacturing wastes discharged into this stream have been found to be very variable in quantity and character, and during the past year in many industries the amount of waste has probably been somewhat limited, as compared with the quantities which have been discharged at other times. Numerous observations have been made of the condition of the river at many points within the limits of the State to determine the effect of the various pollutions and the condition of the stream at various points along its course. The sewer outlets and the effects of sewage disposal at points along the river have also been examined. These investigations and the preparation of plans for improving the condition of the river were in progress at the end of the year.

Miller's River.

The condition of this stream is not objectionable at any point except in the immediate neighborhood of some of the sewer outlets, which in many cases discharge at the bank of the river, where matters from the sewage collect and create objectionable conditions. Chemical analyses of the waters of the stream show an increasing effect of pollution, as compared with previous years.

Nashua River (North Branch).

The pollution of the north branch of the Nashua River has been decidedly greater than in any previous year, but under the provisions of chapter 461 of the Acts of the year 1910 a sewerage commission has been appointed by the city of Fitchburg, and it is understood that it is the intention to begin the construction of works for the purification of the sewage discharged into the stream early in 1911.

Plans for the disposal of the sewage of the town of Leominster were made several years ago, and it is expected that the construction of these works will be begun during the coming year.

Neponset River.

At nearly all of the factories and mills discharging manufacturing wastes into the Neponset River works for the treatment or purification of the wastes have either been established or are at present under construction. In some cases these works seem likely to provide for the efficient purification of all of the wastes now discharged into the stream, while in others the works appear inadequate for the purpose. One of the serious pollutions still remaining is that caused by the sewage, drainage and manufacturing waste discharged through sewers and drains into various streams in the thickly populated portion of the village of Stoughton. These pollutions are very difficult to prevent under present conditions, and the treatment of manufacturing wastes at the factories in this village would be expensive and very likely objectionable. The best plan of preventing the pollution of the tributaries of the Neponset River in this town will be to construct a system of sewerage and sewage disposal, as has recently been done in the town of Norwood, and plans for such a system have been prepared and action taken by the town of Stoughton to secure legislative approval of the construction of a sewerage system. The plans of the works are satisfactory, and if the necessary legislation is obtained, there should be no delay in proceeding with the construction of such portion of the system as may be needed for the relief of the pollution of the stream.

Sudbury River.

This stream is badly polluted by foul wastes chiefly from woolen mills, discharged at Saxonville in the town of Framingham. Plans for collecting and removing this waste from the stream are now being investigated.

Taunton River.

The condition of the Taunton River was examined during the year in connection with a petition from the city of Taunton for a further extension of time for the completion of the sewage-disposal works of that city, including the purification of the sewage and its removal from the river. The results of this examination having shown that the stream is becoming seriously affected by the sewage discharged from

Taunton the Board has limited the further extension of time, and recommended the construction of a disposal works in the near future.

The Nemasket River has been used as a place of disposal for the sewage of the town of Middleborough for many years. The river is also polluted by manufacturing wastes, and its condition below the sewer outlets during the year 1910 has been more objectionable than in any previous year.

Ten Mile River.

The Ten Mile River, which flows through the towns of Attleborough and North Attleborough into the State of Rhode Island, has been badly polluted by sewage discharged into the stream in its course through these towns; but works for the purification of the sewage of each town are now under construction, which will provide for the removal of the sewage from this stream and the prevention of its further serious pollution in the near future.

Ware River.

The condition of the Ware River, which is badly polluted at several points by sewage and manufacturing wastes, continues to show increasing effect of the pollution discharged at Ware, where the condition of the river is rapidly becoming very objectionable.

At the wool-combing plant at Barre, in the upper waters of the river, where a serious nuisance has existed in past years on account of the discharge of wool-scouring wastes into the stream, an improvement has been effected during the past year by the construction of works for the treatment of the wastes from this factory.

Other Streams.

The examinations of the Quinebaug River below Southbridge show no material change in the condition of that stream since last year.

The condition of the Westfield River below the sewer outlets of the town of Westfield has been about the same as last year. The effect of pollution has been more noticeable in the last three years than previously.

Very little change has been noted in the condition of the other rivers in the State which have been examined during the past year.

LAWRENCE EXPERIMENT STATION.

During the year thirty-eight filters have been in operation at the Lawrence Experiment Station in connection with investigations on the purification of domestic sewage, seventeen filters in connection with studies on the purification of manufactural wastes, and eleven filters in connection with studies on different methods for the purification of water. Particular attention has been paid during the year to methods of removing suspended matters from sewage, and also to the effect of the evenness of distribution of sewage upon trickling filters, in order to show clearly the degree of purification that can be obtained in such filters with even and uneven distribution. The efficiency of sand and contact filters of different construction, etc., has been studied, as during previous years, and also certain investigations have been made on the effect upon nitrification in filters receiving domestic and manufactural wastes, of varying amounts of carbonaceous matters of different kinds.

Studies on the purification of water have been made with both slow sand and mechanical filters, particular attention having been paid to a determination of the effect of various rates of operation and of double filtration upon the quality of the effluents from such filters. The studies upon disinfection as applied to water purification, reported upon in part last year, have been continued, and new studies have been begun upon the preliminary clarification of water by upward filtration through coarse materials, and of intermittent sand filtration of polluted water when operating the filter in the same manner as trickling sewage filters. A considerable portion of the laboratory work in connection with the investigation on the pollution of the Merrimack River by industrial wastes, ordered by the last Legislature, has been carried out at the experiment station. In this work, inspection of the fouling of the banks of the river and boats by the polluted river water, and studies on the composition of the wastes and deposits upon the shores and boats, have been made in order to determine, if possible, the fouling due to mill wastes and that due to domestic sewage.

A few years ago the result of an extensive investigation made by the Board on the action of different kinds of water upon lead, tin and galvanized iron pipes was reported. Recently, serious complaint has been made in different parts of the country that waters which have been subjected to certain purification processes are made more corrosive in their action upon various kinds of pipes, hot-water tanks, boiler tubes and other metal surfaces with which they come in contact. This problem is under investigation at the station at the present time, and efforts are being made to determine the degree and cause of such corrosive action and to devise means for preventing it if possible.

In connection with the passage of recent legislation regulating the amount of humidity in mills and the quality of water which may be used in humidifiers in mills, an investigation of the air in such mills has been begun to determine to what extent the bacterial content of the air is influenced by such humidifiers or by the quality of water used in them.

At the laboratory for water analysis at the State House, the work has consisted mainly, as in previous years, of the examination of samples of water from the public water supplies and the rivers in the State, and of the examination of sewage and the effluents from sewage filters from those cities, towns and public institutions which maintain some system of sewage purification. A large part of the analytical work in connection with studies on the corrosive action of certain purified waters upon pipes has been carried out at this laboratory, and, in addition, some experimental work has been undertaken in order to perfect our methods for the determination of small amounts of metals in water. Particularly it has been sought to devise a satisfactory method for the determination of small quantities of tin.

In connection with the regular chemical analyses in this laboratory, a considerable amount of analytical work has been done in connection with mill wastes requiring special examinations. Experiments are being made in this laboratory, also, to test the accuracy of the various instruments used for measuring relative humidity. This work, as that at the experiment station upon the bacterial contents of the rooms in mills, is due to the passage of chapter 543 of the Acts of 1910, which limits the amounts of relative humidity allowable in textile factories wherein water is introduced for humidifying purposes, and places the enforcement of the act in the hands of the State Board of Health.

On April 29, 1910, the Legislature passed the following resolve: —

RESOLVES OF 1910, CHAPTER 88.

RESOLVE RELATIVE TO SANDY POND IN THE TOWN OF LINCOLN.

Resolved, That the state board of health be hereby directed to examine Sandy pond in the town of Lincoln and to ascertain what circumstances, if any, exist detrimental to the interests of the towns or persons lawfully using said pond or its waters by reason of any excessive or unnecessary lowering of the water therein, and to report to the next general court, with such recommendations as to the regulation of the draft of water from said pond or of the height of the same, or the establishment of a low-water mark, as the Board may deem necessary. [*Approved April 29, 1910.*

The report called for follows: —

In accordance with the requirements of chapter 88 of the Resolves of the year 1910, the State Board of Health has examined Sandy Pond in the town of Lincoln to ascertain what circumstances, if any, exist detrimental to the interests of the towns or persons using said pond or its waters, by reason of any excessive or unnecessary lowering of the water therein, and presents herewith its report.

Sandy Pond is the source of water supply of the towns of Lincoln and Concord, the former of which had a population in 1910 of 1,175, and the latter, 6,421. These towns were authorized to take water from Sandy Pond for domestic and other purposes by the provisions of chapter 188 of the Acts of the year 1872, sections 11 and 12 of which are as follows: —

> SECTION 11. All provisions of this act concerning the town of Concord, shall apply to the town of Lincoln; and if, in the future, the water of said pond shall prove insufficient for both, the town of Lincoln shall be first supplied.
>
> SECTION 12. This act shall be void, as regards either town of Concord or Lincoln, unless accepted by a majority of legal voters of such town present and voting thereon, at a legal meeting held for the purpose within one year from the time this act goes into effect.

Works for supplying water to the town of Concord were built in 1874, and a system of water supply was built in Lincoln in the years 1874 and 1875. The town of Concord is supplied by gravity from an intake at the northerly end of the pond, situated 5.5 feet below the former high-water level and 7 feet below the present high-water level, the pond having been raised by the town of Concord about 1.5 feet several years ago. When the water fell to a very low level, early in the year 1909, the town of Concord set up a pump at the intake, and pumped water into the intake gatehouse in order to maintain the supply to the town.

In the very dry season of 1883 Sandy Pond was drawn down considerably, and the town of Concord obtained the right to take water from Nagog Pond, in the towns of Acton and Littleton. The act was accepted by the town and works were built for introducing a gravity supply from that source in 1909, water from Nagog Pond being first supplied in September of that year. Nagog Pond has an area of 287 acres and a drainage area, including the pond, of 1.52 square miles, and is capable of supplying a much larger quantity of water than Sandy Pond.

The town of Lincoln obtains its supply by pumping from the extreme southerly end of Sandy Pond, and on account of the low level to which the water has been drawn of late years the intake has been extended, and provision has been made for a further extension if necessary.

An examination of such information as is available as to the consumption of water from Sandy Pond by Concord and Lincoln indicates that the amount used has been increasing in recent years. Early in 1908 the actual measurement of the water drawn from the pond was begun by the town of Concord, and in the latter part of 1908 a Venturi meter was introduced by the town of Lincoln, to measure more accurately than was practicable by pumping records the quantity of water supplied to that town. From these measurements it appears that the quantity of water used in the town of Lincoln from May to December, 1909, averaged 173,000 gallons per day, or 194 gallons per inhabitant, and the quantity used in 1910 up to the end of November averaged 194,000 gallons per day, or 165 gallons per inhabitant. In the town of Concord the quantity of water used in 1909 was 452,000 gallons per day, or 73 gallons per inhabitant, and in the first eleven months of 1910, 487,000 gallons per day, or 76 gallons per inhabitant.

The actual quantity drawn from Sandy Pond by each town during these years, by months, so far as is shown by the records kept by the towns, is as follows: —

MONTH.	Concord (Gallons).	Lincoln (Gallons).	Total (Gallons).
1909.			
January,	420,000	-[1]	-
February,	404,000	-[1]	-
March,	496,000	-[1]	-
April,	330,000	-[1]	-
May,	400,000	146,000	546,000
June,	438,000	165,000	603,000
July,	824,000	220,000	1,044,000
August,	627,000	199,000	826,000
September,	366,000[2]	165,000	531,000
October,	168,000	177,000	345,000
November,	173,000	153,000	326,000
December,	39,000	159,000	198,000
Average for year,	391,000	-	-
Average for eight months,	379,000	173,000	552,000
1910.			
January,	36,000	154,000	190,000
February,	50,000	-[1]	-
March,	92,000	-[1]	-
April,	40,000	162,000	202,000
May,	34,000	173,000	207,000
June,	52,000	216,000	268,000
July,	61,000	276,000	337,000
August,	15,000	209,000	224,000
September,	15,000	197,000	212,000
October,	16,000	182,000	198,000
November,	27,000	175,000	202,000
Average for eleven months,	40,000	-	-
Average for nine months,	33,000	194,000	227,000

[1] No records.

[2] Nagog Pond turned on September 15.

It will be seen from the above table that the total quantity of water drawn by the town of Concord from Sandy Pond, after the supply from Nagog Pond became available, on Sept. 15, 1909, was rapidly reduced, and in 1910 the quantity drawn from Sandy Pond has averaged only about 40,000 gallons per day. The quantity used by the town of Lincoln has apparently amounted to about 194,000 gallons per day, making the total quantity drawn from the pond in 1910 about 234,000 gallons per day. It has been estimated that the pond is capable of yielding, in a series of dry years, about 600,000 gallons per day, so that the rate of consumption of water from the pond during the past year has been a little less than 40 per cent. of the quantity that it is capable of yielding continuously. Previous to September, 1909, the two towns together used from Sandy Pond a quantity amounting probably to as much as 600,000 gallons of water per day, and possibly more, and the level of the pond has been gradually sinking since May, 1904, when the water last ran over the dam at the outlet. The height of water has fluctuated with the seasons, rising in the spring and falling during the summer and fall to a minimum level in the late fall and early winter. The maximum and minimum level reached by the water in each season since water last ran from the outlet of the pond in 1904 has been as follows: —

Year.	Maximum Height of Water.		Minimum Height of Water.	
	Date.	Feet below Full Pond.	Date.	Feet below Full Pond.
1904, ...	May 2, ...	0.30[1]	December 12, . .	2.10
1905, ...	April 14, ...	1.15	December 16, . .	4.15
1906, ...	June 16, ...	2.34	December 28, . .	4.80
1907, ...	June 20, ...	3.52	September 22, . .	5.73
1908, ...	May 23, ...	2.66	February 6,[2] . .	6.75
1909, ...	May 18, ...	4.78	November 18, . .	8.03
1910, ...	June 13, ...	4.96	November 21, . .	6.85

[1] Above full pond.

[2] 1909.

Under present conditions, with the pond drawn down from 3 to 7 feet or more, a large area around the shores has been exposed continuously for several years, particularly near the upper end, where the water at full pond is comparatively shallow. Examinations by the Board show that an extensive growth of weeds and grasses, with occasional small bushes, has sprung up upon the exposed shores of the pond, especially over this shallow area, where the soil consists largely of fine sand or silt. In places where the exposed areas are covered with coarse gravel the amount of vegetation is less.

In the opinion of the Board the contact of the water with these organic growths on the shores and bottom of the pond is likely to be detrimental to its quality when it again rises and overflows these shallow areas.

The drawing down of the pond to the low level which it has reached recently is also objectionable, in that it reduces considerably the head available for the supply of the town of Concord and increases the lift of the pumps supplying the town of Lincoln. Since September, 1909, the town of Concord has been able to supply itself very largely with water from Nagog Pond, and has limited itself to a very small draft upon Sandy Pond, so that the use of the water from the latter source has been reduced, as already stated, to less than 40 per cent. of the amount used in the previous year. The capacity of the pond in a series of dry years is probably more than two and a half times the quantity drawn in 1910, and under the circumstances, at the rate at which water has been drawn during the past year, the pond is certain to fill rapidly and again overflow in the spring of nearly every year. In view of the present very limited draft of water from the pond by the town of Concord, it appears to the Board unnecessary to limit the use of water from the pond while the present reasonable use continues. There will, of course, be an increase in the requirements of the town of Lincoln, and much more water can be used, if required, by the town of Concord than has been drawn in the last few months; but the town of Concord having provided itself with an auxiliary source of water supply, there will now be no need of drawing the water of Sandy Pond to the former low levels for a long time in the future. At some future time, when it becomes necessary to use greater quantities of water from the pond, restrictions may become necessary or desirable, but in the opinion of the Board it is not for the best interests of either town to limit the quantity of water that may be drawn from the pond, or to fix a low-water mark, or place other limit as to the height at which the water must be maintained.

In view of the circumstances, the Board finds no necessity at the present time for regulating the draft of water from Sandy Pond or the height of the same, or for the establishment of a low-water mark.

Changes in Legislation which affect the Work of the State Inspectors of Health.

During the legislative session of 1910 the following acts were passed: —

1. Relative to the health districts and to the inspectors of health of the Commonwealth.

2. Relative to the examination of police station houses, lock-ups and houses of detention; to ascertain the sanitary condition of such houses and lock-ups.

3. Relative to regulating the humidity and temperature of the atmosphere in textile factories.

4. Relative to trades, processes of manufacture or occupations injurious to the health of minors under eighteen years of age.

They are as follows: —

ACTS OF 1910, CHAPTER 523.

AN ACT RELATIVE TO THE HEALTH DISTRICTS AND TO THE INSPECTORS OF HEALTH OF THE COMMONWEALTH.

Be it enacted, etc., as follows:

SECTION 1. Chapter five hundred and thirty-seven of the acts of the year nineteen hundred and seven is hereby amended by striking out section one and inserting in place thereof the following: — *Section 1.* The state board of health shall, as soon as may be after the passage of this act, divide the commonwealth into not more than fifteen districts, to be known as health districts, and the board may from time to time modify the district lines in such manner as it may deem necessary or proper for carrying out the purposes of this act.

SECTION 2. Said chapter five hundred and thirty-seven is hereby further amended by striking out section two and inserting in place thereof the following: — *Section 2.* After the division aforesaid has been made the state board of health, whenever it becomes necessary to appoint or to re-appoint a state inspector of health, shall, with the consent of the governor and council, appoint in each health district one practical and discreet person, learned in the science of medicine and hygiene, to be state inspector of health in that district. Every nomination for such office shall be made at least seven days prior to the appointment. A state inspector of health thus appointed shall hold his office for a period of five years from the time of his appointment, but shall be liable to removal from office by the state board of health at any time.

SECTION 3. Said chapter five hundred and thirty-seven is hereby further amended by striking out section six and inserting in place thereof the following: — *Section 6.* The state board of health, with the approval of the governor and council, shall from time to time establish the salaries of said state inspectors of health, having regard in each district to the extent of territory, the number of inhabitants, the character of the business there carried on, and the amount of time likely to be required for the proper discharge of the duties. The salaries thus established shall be paid from the treasury of the commonwealth monthly. [*Approved May 13, 1910.*

ACTS OF 1910, CHAPTER 405.

AN ACT RELATIVE TO THE DUTIES OF INSPECTORS OF HEALTH, AND TO THE STATE BOARD OF HEALTH.

SECTION 1. The state inspectors of health, in addition to the duties provided for by chapter five hundred and thirty-seven of the acts of the year nineteen hundred and seven, shall annually make such examination of police station houses, lock-ups and houses of detention as in the opinion of the state board of health may be necessary to ascertain the sanitary condition of such houses and lock-ups.

SECTION 2. The state board of health shall make rules for police station houses, lock-ups and houses of detention, regarding the care and use of drinking cups and of dishes used for food; the care and use of bedding, and the ventilation of the buildings. Such rules may be general, or may be applicable to a single station house, house of detention or lock-up; and a copy thereof shall be sent by said board to the mayor of every city and to the selectmen of every town to which the rules apply. It shall be the duty of the mayors of cities and the selectmen of towns to which the rules so made apply to see that the rules are enforced.

SECTION 3. No station house, house of detention or lock-up shall be built hereafter until the state board of health has approved in writing the plans, provisions for lighting, heating and ventilation and the disposal of sewage, and the dimensions and form of construction of the cells.

SECTION 4. In order to carry out the provisions of this act there may be expended from the treasury of the commonwealth, annually, a sum not exceeding eight hundred dollars in addition to the five thousand dollars authorized by section seven of chapter five hundred and thirty-seven of the acts of the year nineteen hundred and seven.

SECTION 5. This act shall take effect upon its passage. [*Approved April 16, 1910.*

ACTS OF 1910, CHAPTER 543.

AN ACT RELATIVE TO REGULATING THE HUMIDITY AND TEMPERATURE OF THE ATMOSPHERE IN TEXTILE FACTORIES.

Be it enacted, etc., as follows:

SECTION 1. In every weaving and spinning department in a textile factory wherein water is introduced for humidifying purposes there shall be provided, maintained and kept in correct working order, for the purpose of recording and regulating the humidity of the atmosphere and the temperature, at least one set of standardized wet and dry bulb thermometers, and, if required by a state inspector of health, two sets of such thermometers, and the following regulations shall be observed in the use of the thermometers: (a) The thermometers shall be placed as directed or sanctioned by a state inspector of health, and shall be plainly visible to the workers. (b) The occupier or manager or person for the time being in charge of the weaving or spinning department in question shall read the thermometers thrice in the day, namely, between seven and eight o'clock in the forenoon, between ten and eleven o'clock in the forenoon and between three and four o'clock, except in rooms which are lighted by gas, and then between four and five o'clock, in the afternoon of every day on which any persons are employed in any weaving or spinning department, and he shall record the readings of each thermometer in such department at each of the said times upon a form provided for the purpose, which, together with the regulations relating thereto, shall be furnished by the state board of health. The records of the readings shall not be destroyed until they have first been seen by the state inspector of health in whose district the factory is situated, and then not without his knowledge and consent.

SECTION 2. Section one shall not apply to textile factories already equipped with, or which become equipped with, such a number and type of standardized self-registering hygrometers, or psychrometers, or hygrometric system, as meet the approval of the state board of health, provided that the manner of using the same is approved by the state inspector of health in whose district the factory is situated, and provided that the records of the readings from the said hygrometers, or hygrometric system installed, are not destroyed without the knowledge and consent of said inspector.

SECTION 3. Section one shall not apply to textile factories the occupier or manager or person in charge of which makes use of the sling hygrometer with the express purpose of quickly and accurately determining the actual moisture and temperature of a weaving or spinning department as frequently and in such a manner as is approved by the state inspector of health in whose district the factory is situated, and provided that the records of the readings from the use of the said hygrometer are not destroyed without the knowledge and permission of said inspector.

SECTION 4. No owner, occupier or manager or person for the time being in charge of a textile factory shall permit the relative humidity in a weaving or spinning department in the textile factory under his control to exceed the following limits:

I. Dry Bulb Thermometer Readings. Degrees Fahr.	II. Wet Bulb Thermometer Readings. Degrees Fahr.	III. Percentage of Humidity.	I. Dry Bulb Thermometer Readings. Degrees Fahr.	II. Wet Bulb Thermometer Readings. Degrees Fahr.	III. Percentage of Humidity.
60	58	88	78	73.5	77
61	59	88	79	74.5	77.5
62	60	88	80	75.5	77.5
63	61	88	81	76	76
64	62	88	82	76.5	74
65	63	88	83	77.5	74
66	64	88	84	78	72
67	65	88	85	79	72
68	66	88	86	80	72
69	67	88	87	80.5	71
70	68	88	88	81.5	71
71	68.5	85.5	89	82.5	71
72	69	84	90	83	69
73	70	84	91	83.5	68
74	70.5	81.5	92	84.5	68
75	71.5	81.5	93	85.5	68
76	72	79	94	86	66
77	73	79	95	87	66

SECTION 5. Water used for humidifying purposes in a textile factory shall be taken either from a public supply of drinking water, or from some other source of pure water, or from a supply of water which, although in the opinion of the state board of health not suitable for drinking purposes is sufficiently free from impurities as not to be dangerous to the health

of employees when used for humidifying purposes; and all ducts for the introduction or distribution of humidified air shall be kept clean.

SECTION 6. This act shall be enforced by the state inspectors of health under the supervision of the state board of health. Whoever fails to comply with the provisions contained herein after being requested so to do by a state inspector of health shall be fined not more than fifty dollars for each offence.

SECTION 7. To provide for the expenses necessary in carrying out the provisions of this act, in connection with and in addition to the duties provided for by chapter five hundred and thirty-seven of the acts of the year nineteen hundred and seven, there may be expended out of the treasury of the commonwealth annually a sum not exceeding one thousand dollars in addition to the five thousand dollars provided for by section seven of said chapter five hundred and thirty-seven. [*Approved May 23, 1910.*

ACTS OF 1910, CHAPTER 404.

AN ACT RELATIVE TO THE EMPLOYMENT IN DANGEROUS TRADES OF MINORS UNDER THE AGE OF EIGHTEEN YEARS.

Chapter five hundred and fourteen of the acts of the year nineteen hundred and nine is hereby amended by striking out section seventy-five and inserting in place thereof the following: — *Section 75.* The state board of health may from time to time upon the written application of any citizen of the commonwealth, or upon its own initiative, after such investigation as it considers necessary, determine whether or not any particular trade, process of manufacture or occupation, or any particular method of carrying on such trade, process of manufacture or occupation, is sufficiently injurious to the health of minors under eighteen years of age employed therein to justify their exclusion therefrom, and every decision so rendered shall be conclusive evidence of the facts involved therein, except so far as the same may later be revoked or modified by a subsequent decision of the board. Whoever, after being notified that the state board of health has determined that a particular trade, process of manufacture, occupation or method is injurious as above stated, employs therein a minor under eighteen years of age shall be punished by a fine of not more than two hundred dollars and not less than fifty dollars for each offence, unless prior to the time of such employment such determination shall have been revoked or modified so as not to include the employment complained of. [*Approved April 16, 1910.*

The State Board of Health hereby declares the processes named in the schedule hereunder to be injurious to the health of minors within the meaning of chapter 404, Acts of 1910, provided that the law shall not apply to any factory wherein such special measures are adopted as appear to the State Inspector of Health to be reasonably practicable and meet the necessities of the case: —

I. Processes involving exposure to poisonous dusts or substances: —
  1. Processes in the manufacture of white, red, orange or yellow lead.
  2. Processes in the manufacture of lead pipe, solder and plumbers' supplies.
  3. Cutting metal articles with a mixture of lead and tin, or lead alone.
  4. Processes involving exposure to lead and the dust of plumbago in electrotyping.
  5. Processes involving the handling of white lead or lead monoxide (litharge) in rubber factories.
  6. Lead paint grinding.
  7. Lead working in the manufacture of storage batteries.
  8. File cutting by hand.
  9. Typesetting, cleaning or handling type in printing offices.
  10. Glazing in pottery establishments.

II. Processes involving exposure to irritating dusts: —
  1. Processes involving exposure to the dust of graphite in the manufacture of stove polish.
  2. The operation of bronzing in the lithographing business, and the consequent exposure to bronze powder.
  3. Cutlery grinding, and grinding or polishing in the manufacture of machinery, machine parts and metal supplies; and grinding, glazing or polishing on emery or buffing wheels.
  4. Cutting, boring, turning, planing, grinding, doming, facing or polishing pearl shell.
  5. Talc dusting in rubber works.
  6. Sorting, dusting, cutting or grinding rags.

III. Processes involving exposure to poisonous gases and fumes: —
  1. Spreading rubber on cloth and the consequent exposure to naphtha in the manufacture of rubber goods.
  2. The use of naphtha in cement work in rooms in shoe and rubber factories which are not provided with mechanical means of ventilation, where the mixture containing naphtha is allowed to remain in uncovered receptacles.
  3. Processes involving exposure to naphtha in the manufacture of japanned or patent leather.
  4. Exposure to escape of fumes or gases from lead processes.

IV. Processes involving exposure to irritating gases and fumes: —
  1. Gassing in textile factories.
  2. Singeing in print works, bleaching and dyeing works.
  3. Dipping metal in acid solutions.

V. Processes involving exposure to extremes of heat and other conditions which promote susceptibility to disease.
  1. Melting or annealing glass.

5. The Legislature of 1910 amended sections 80 and 82, chapter 514, Acts of 1909, so that State Inspectors of Health now have authority to issue orders relative to water-closets for both sexes in factories in which five or more persons are employed, and in factories, workshops, mercantile or other establishments or offices in which two or more children or women are employed.

THE SUPERVISION OF THE BUSINESS OF PLUMBING.

ACTS OF 1910, CHAPTER 597.

AN ACT RELATIVE TO THE SUPERVISION OF THE BUSINESS OF PLUMBING.

Be it enacted, etc., as follows:

SECTION 1. The compensation of the state examiners of plumbers, together with the travelling and other necessary expenses of the clerk and the travelling and other necessary expenses of the other two state examiners to an amount not exceeding in the aggregate five hundred dollars annually for such expenses of said other two state examiners, shall, when approved by the chairman of the state board of health and by the governor and council, be paid from the treasury of the commonwealth.

SECTION 2. Certificates of registration in accordance with the provisions of section two of chapter four hundred and fifty-five of the acts of the year eighteen hundred and ninety-four shall be issued to all persons who have been legally registered under the provisions of said chapter, provided that such persons, after notice, register anew with the state examiners of plumbers on or before the first day of September, nineteen hundred and ten.

SECTION 3. So much of chapter five hundred and thirty-six of the acts of the year nineteen hundred and nine as is inconsistent herewith is hereby repealed.

SECTION 4. This act shall take effect upon its passage. [*Approved June 9, 1910.*

At a meeting of the State Board of Health held on July 21, 1910, Mr. Charles R. Felton was reappointed to the State Board of Examiners of Plumbers.

A detailed report of the work carried on by this Board in 1910, together with recommendations for legislation, appears in the Supplement.

PROPRIETARY MEDICINES.

During the year 6 proprietary preparations containing alcohol, and with no statement as to the amount, were advertised as unsalable at retail, under the provisions of chapter 386 of the Acts of 1906, namely: —

Dr. Carpenter's Equalizing Drops. Prepared and supplied only by Drs. Carpenter (Drs. Geo. C. and Mary A. Carpenter), Lowell, Mass.

Improved Sun Cholerine Mixture. Prepared only by the Walker-Rintels Drug Company, 52 Temple Place, 166 Summer Street, opposite Station, and 244 Boylston, corner Church Street, Boston.

Vino de Quina y Cacao del Dr. Castillo. Gutierrez Hermanos, Jerez.

Highland Malt Extract. The Springfield Breweries Company, Springfield, Mass., U. S. A.

Coke Dandruff Cure and Hair Tonic.[1] A. R. Bremer Company, New York, Chicago.

Mysterious Pain Cure. Junius Barnes and Son, Proprietors, Burlington, Vt. (Also contained laudanum.)

The following preparations were also advertised as unsalable at retail, under the provisions of chapter 386 of the Acts of 1906: —

Gauvin's Aniseed Syrup (Sirop D'Anis Gauvin).[1] J. A. E. Gauvin, Dispensing Chemist, 850 St. Catherine Street East, Montreal; Branch, Lowell, Mass. (Contained morphine, with no statement as to the percentage of morphine present.)

Kefaline: The Celebrated Headache Cure. Manufactured by the Kefaline Company, Boston, Mass. (Contained acetanilid, with no statement as to the percentage of acetanilid present.)

FOOD AND DRUG INSPECTION.

The number of samples of foods and drugs collected and examined during the year ended Nov. 30, 1910, was 7,805, and the total number since the work was begun in 1882 has now reached 198,425.

During the year 257 prosecutions were made in the various courts of the Commonwealth, bringing the total number to 3,829. The details are presented in the Supplement.

INSPECTION OF LIQUORS.

The work of the Board in connection with the duties of the office of inspector and assayer of liquors, transferred to the Board in 1902, is reported upon in the Supplement.

INSPECTION OF DAIRIES.

During the year ended Nov. 30, 1910, 2,053 dairies were examined by the Board's veterinarian, and the attention of 737 proprietors and of boards of health of cities and towns, wherein the dairies were situated or the product thereof sold, was called to a total of 2,515 objectionable conditions.

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[1] Prohibition later revoked.

Of the total number of dairies examined, 1,983 were situated in Massachusetts and 70 in the neighboring States. The details will be found in the Supplement.

Reports upon Fatality of Certain Diseases, Official Returns of Deaths in Cities and Large Towns, the Vital Statistics of the State, the Production, Distribution and Use of Diphtheria Antitoxin and Vaccine, and upon Bacteriological Diagnosis are presented in the Supplement.

ROUTINE WORK OF THE BOARD.

Statistical Table for the Year ended Nov. 30, 1910.

Whole number of samples of food and drugs examined,	7,805
Samples of milk examined (included in the foregoing),	5,396
Number of prosecutions against offenders during the year,	257
Number of convictions during the year,	244
Amount of fines imposed,	$5,395.21
Number of dairies examined,	2,053
Number of packages of antitoxin of 1,500 units each issued to cities and towns,	92,623
Number of tubes of vaccine issued to cities and towns,	76,690
Number of bacterial cultures made for diagnosis of diphtheria in cities and towns,	3,531
Number of examinations made for diagnosis of tuberculosis,	1,997
Number of examinations of blood made for diagnosis of malarial infection,	56
Number of examinations of blood made for diagnosis of typhoid fever,	874
Number of nitrate of silver solution outfits for use in cases of ophthalmia neonatorum sent to physicians (5,278) and boards of health (1,641) during the period July to Nov. 30, 1910,	6,929
Number of notices of cases of infectious diseases received and recorded under the provisions of chapter 75, section 52, Revised Laws,	50,867
Force employed in general work of Board at central office, State House: —	
Secretary,	1
Assistant to the secretary,	1
Clerks,	7
Messengers,	2
Sanitary inspector of dairies,	1
Total,	12

Force employed for food and drug inspection: —

Chemists and assistants,	4
Inspectors,	4
Total,	8

Force employed at laboratory (Bussey Institution): —

Pathologist,	1
Expert assistants,	2
Stable helpers,	7
Total,	10

Under the Provisions of Sections 112 to 118 of Chapter 75, Revised Laws.

Applications for advice from cities, towns and others: —

Relating to water supply,	96
Relating to ice supply,	8
Relating to sewerage and drainage,	26
Relating to pollution of streams,	4
Miscellaneous,	5
Total,	139

Number of samples of water, ice and sewage examined chemically at the laboratory, Room 502, State House,	7,238
Number of samples of water, ice and sewage examined microscopically at the laboratory, Room 502, State House,	2,463
Number of samples of water examined for lead, zinc, copper, etc., in connection with corrosion of pipes experiments,	124
Number of samples of sewage examined for alcohol in connection with special investigations,	47
Number of samples of water, sewage, ice, etc., examined chemically and bacterially at Lawrence Experiment Station,	3,229
Number of samples of water, sewage and ice examined bacterially,	2,967
Number of samples of sand examined chemically and mechanically,	13
Number of samples of sand examined chemically only,	71
Number of samples of sand examined mechanically only,	20
Number of samples of air examined bacterially,	272
Total number of samples examined,	16,444

Force employed at Central office:—		
Chief engineer,	1	
Assistant engineers,	12	
Stenographers and clerks,	4	
Messenger,	1	
		18
Force employed at laboratory, Room 502, State House:—		
Chief chemist,	1	
Assistant chemists,	7	
Biologist,	1	
Stenographer and clerks,	2	
		11
Force employed at Lawrence Experiment Station:—		
Assistant chemists,	2	
Bacteriologists,	2	
Other assistants and laborers,	3	
		7
Total ordinary force,		36

The number of applications for advice under the provisions of the acts relating to water supply and sewerage, received since July, 1886, when these acts first went into operation, is as follows:—

1886,	8	1900,	104
1887,	22	1901,	105
1888,	28	1902,	93
1889,	38	1903,	129
1890,	23	1904,	125
1891,	53	1905,	105
1892,	56	1906,	130
1893,	51	1907,	125
1894,	53	1908,	134
1895,	52	1909,	128
1896,	65	1910,	139
1897,	59		
1898,	75	Total,	1,979
1899,	79		

APPROPRIATIONS.

The appropriations for the year ended Nov. 30, 1910, as recommended by the Board in the annual estimates made under the provisions of chapter 6, section 26, of the Revised Laws, were as follows:—

For the general expenses of the Board,	$27,500 00
For the inspection of food and drugs,	14,500 00
For the production and distribution of antitoxin and vaccine,	20,000 00
For the purity of inland waters,	36,000 00
For the examination of sewer outlets and Neponset River,	14,000 00
For printing the annual report,	3,000 00
State Inspectors of Health,	31,800 00
For the prevention of ophthalmia neonatorum,	2,500 00
Total,	$149,300 00

EXPENDITURES.

The expenditures under the different appropriations for the year ended Nov. 30, 1910, were as follows: —

General Expenditures.

Appropriation (including appropriation for investigation of anterior poliomyelitis and appropriation for Sandy Pond, Merrimack River, etc.),	$27,500 00

Salaries,	$14,677 45
Traveling expenses,	2,417 08
Stationery, maps and blue prints,	485 88
Printing,	2,871 99
Books, subscriptions and binding,	511 78
Advertising,	98 33
Express charges,	113 58
Extra services,	745 16
Messenger,	185 80
Postage and postal orders,	1,282 76
Telephone and telegraph messages,	377 05
Typewriting supplies,	110 58
Special investigations,	316 71
Sundry office supplies,	337 14
Laboratory supplies,	315 87
Labor and materials,	38 19
Miscellaneous,	114 44
Total,	$24,999 79

Expenditures for the Production and Distribution of Antitoxin and Vaccine for the Year ended Nov. 30, 1910.

Appropriation,	$20,000 00
Salaries,	$7,678 15
Printing,	296 16
Stationery,	52 50
Laboratory supplies,	2,862 04
Laboratory construction,	1,302 82
Rent of laboratory and stable,	2,008 32
Express charges,	40 47
Traveling,	7 66
Purchase of animals,	1,663 09
Board of horses and horse shoeing,	71 72
Services of veterinary,	22 00
Food for animals,	3,013 08
Rental of telephone, messages and postage,	163 30
Extra services,	149 85
Ice,	79 20
Gas, electric lighting, heating and water,	357 05
Miscellaneous,	224 90
Total,	$19,992 31

Expenditures under the Provisions of the Food and Drug Acts for the Year ended Nov. 30, 1910.

Appropriation,	$14,500 00
Salaries of analysts,	$5,500 00
Salaries of inspectors,	5,206 05
Traveling expenses and purchase of samples,	2,903 06
Apparatus and chemicals,	324 63
Printing,	52 20
Services, cleaning laboratory,	104 00
Express and telephone,	23 64
Sundry laboratory supplies,	152 39
Books, binding and stationery,	27 45
Extra services,	182 32
Advertising,	23 38
Total,	$14,499 12

For carrying out the Provisions of the Act to protect the Purity of Inland Waters, and to require Consultation with the State Board of Health regarding the Establishment of Systems of Water Supply, Drainage and Sewerage.

Appropriation for the year ended Nov. 30, 1910, ... $36,000 00

Salaries, including wages of laborers at Lawrence Experiment Station,	$30,064 78
Apparatus and materials,	1,592 01
Rent of Lawrence Experiment Station,	150 00
Repairs and maintenance, Lawrence Experiment Station,	186 00
Traveling expenses,	1,057 91
Express charges,	1,725 99
Books and binding,	188 62
Maps and blue prints,	98 68
Stationery, drawing materials and typewriting supplies,	480 42
Telephone and telegraph messages and postage,	48 65
Extra services,	107 57
Services, collecting samples and reading gauges,	19 45
Miscellaneous,	279 69
Total,	$35,999 77

For the Examination of Sewer Outlets, under the Provisions of Section 4 of Chapter 75 of the Revised Laws.

Appropriation for the year ended Nov. 30, 1910, ... $14,000 00

Salaries, including wages of laborers at Lawrence Experiment Station,	$10,197 17
Apparatus and materials,	507 30
Labor,	1 10
Traveling expenses,	2,200 68
Express charges,	146 92
Telephone and telegraph messages and postage,	103 94
Extra services,	40 45
Services, collecting samples and reading gauges,	75 85
Books, maps, blue prints and binding,	309 84
Stationery, drawing materials and typewriting supplies,	358 77
Miscellaneous,	57 63
Total,	$13,999 65

Expenses under the Provisions of the Act to provide for the Establishment of Health Districts and the Appointment of Inspectors of Health (Chapter 537, Acts of 1907; Chapters 405 and 543, Acts of 1910), for the Year ended Nov. 30, 1910.

Appropriation: —	
Salaries of State Inspectors of Health,	$25,000 00
Other expenses necessary in carrying out the provisions of the health district acts,	6,800 00
Total,	$31,800 00

Salaries of State Inspectors of Health,	$25,000 00
Salaries of clerical and other assistants,	1,700 00
Extra services,	531 50
Traveling expenses,	2,486 78
Express charges,	38 00
Printing,	662 81
Books and stationery,	197 95
Postage,	503 84
Typewriting supplies and typewriting,	212 88
Office supplies,	44 95
Laboratory apparatus,	74 48
Telephone and telegraph messages,	101 67
Maps and blue prints,	8 05
Miscellaneous,	70 72
Total,	$31,633 63

For carrying out the Provisions of the Act relative to the Board of Approval of Sewerage Works in the Watershed of the Charles River Basin by the City of Boston (Chapter 376 of the Acts of 1908).

Appropriation for the year ended Nov. 30, 1910,	$1,800 00

Salaries,	$1,703 33
Traveling expenses,	18 25
Stationery and drawing materials,	20 51
Maps and blue prints,	44 89
Miscellaneous,	12 91
Total,	$1,799 89

For carrying out the Provisions of the Act relative to the Supervision of the Business of Plumbing (Chapter 536 of the Acts of 1909).

Appropriation for the year ended Nov. 30, 1910,	$4,400 00
Salary, clerk,	$2,000 00
Wages, second and third examiners,	700 00
Traveling expenses,	517 14
Express charges,	29 66
Printing,	512 40
Postage,	420 87
Books and stationery,	85 28
Plumbers' materials,	30 25
Cleaning,	21 25
Extra services,	623 68
Advertising,	55 20
Miscellaneous,	5 64
Total,	[1] $5,001 37

For carrying out the Provisions of the Act relative to the Prevention of Ophthalmia Neonatorum (Chapter 458 of the Acts of 1910).

Appropriation, April 27 to Nov. 30, 1910,	$2,500 00
Salaries,	$40 00
Ophthalmia neonatorum outfits,	888 79
Printing,	43 85
Postage,	261 57
Extra services,	62 08
Express,	4 50
Miscellaneous,	1 40
Total,	$1,302 19

HENRY P. WALCOTT.
HIRAM F. MILLS.
ROBERT W. LOVETT.
GERARD C. TOBEY.
JAMES W. HULL.
CHARLES H. PORTER.
JULIAN A. MEAD.

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[1] This deficit of $601.37 was duly allowed by the Governor and Council.

SUPPLEMENT.

WATER SUPPLY AND SEWERAGE.

ADVICE TO CITIES, TOWNS AND PERSONS.

ADVICE TO CITIES, TOWNS AND PERSONS.

Under the provisions of the Revised Laws (chapter 75, section 117), the State Board of Health is required to

> consult with and advise the authorities of cities and towns and persons having, or about to have, systems of water supply, drainage or sewerage, as to the most appropriate source of water supply, and the best method of assuring its purity or as to the best method of disposing of their drainage or sewage with reference to the existing and future needs of other cities, towns or persons which may be affected thereby. It shall also consult with and advise persons engaged or intending to engage in any manufacturing or other business whose drainage or sewage may tend to pollute any inland water as to the best method of preventing such pollution, and it may conduct experiments to determine the best methods of the purification or disposal of drainage or sewage. No person shall be required to bear the expense of such consultation, advice or experiments. Cities, towns and persons shall submit to said board for its advice their proposed system of water supply or of the disposal of drainage or sewage, and all petitions to the general court for authority to introduce a system of water supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of said board thereon.

During the year 1910 the Board has given its advice to the following cities, towns and persons who have applied for such advice under the provisions of this act or under special acts relating to water supply and sewerage.

Official communications were made during the year under the provisions of acts relating to water supply and to sources of ice supply, as follows: —

WATER SUPPLY.

Acton (well in South Acton).
Acton (well in West Acton).
Agawam.
Amesbury.
Amherst.
Ashland (two).
Ashland (well).
Attleborough (two).
Attleborough (J. M. Fisher Company).
Attleborough (Frank Mossberg Company).
Attleborough (spring).

Belchertown (spring).
Beverly (United Shoe Machinery Company).
Bourne (Sagamore) (two).
Braintree.
Braintree (Rice & Hutchins).
Cambridge (well).
Concord.
Cummington.
Dalton (Dalton Fire District).
Danvers (spring).
Dartmouth (wells at Lincoln Park) (two).
Dracut (Tyng's Pond) (two).
Fairhaven (wells).
Gardner.
Gloucester (West Gloucester).
Granville.
Greenfield (Fire District No. 1).
Hadley (Hadley Water Supply District).
Hamilton (well at Asbury Grove).
Hardwick (Gilbertville).
Harvard (wells) (two).
Holyoke (two).
Hudson.
Huntington (Huntington Fire District) (two).
Hyde Park (two).
Lancaster (State Industrial School for Girls).
Lexington (Jefferson Union Company).
Lowell.
Lynn (two).
Lynn (Creighton Bros.).
Lynn (Springs in South Peabody).
Medway (two).
Middleborough.
Newton.
Norfolk (American Felt Company).
North Adams (Barber Leather Company).
North Andover (Davis & Furber Company).
Northborough (Whiting Manufacturing Company).
Northfield.
Norton (wells).
Palmer (three).
Palmer (springs in Three Rivers).
Palmer (Thorndike).
Peabody.
Peabody (spring).
Pepperell.
Pittsfield (four).
Pittsfield (Pittsfield Junction).
Plymouth.
Randolph and Holbrook.
Rockport (well).
Russell.
Salem.
Salem (spring).
Salem (Salem Laundry Company).
South Hadley (Fire District No. 2) (two).
Spencer.
Springfield.
Stockbridge.
Stoughton (Plymouth Rubber Company).
Sutton (Army and Navy Cotton Duck Company).
Taunton.
Taunton (well).
Townsend (well).
Tyngsborough (Willow Dale).
Wakefield.
Walpole (F. W. Bird & Son).
Westfield (Westfield State Sanatorium).
Weston.
Weston (Hook & Hastings Company).
Westport (Westport Manufacturing Company) (two).

ICE SUPPLY.

Ashburnham.
Concord.
Lexington.
Medford.
Melrose.
Newton.
Northampton.
Quincy.
Salisbury.
Whitman.
Woburn.

Official communications were made during the year under general and special acts relating to sewerage and sewage disposal, as follows: —

Amherst (three).
Attleborough.
Boston.
Braintree.
Brockton.
Canton (Plymouth Rubber Company).
Danvers (Creese & Cook Company).
Greenfield (two).
Hinsdale.
Holden (School building).
Hyde Park (Tileston & Hollingsworth Company).
Leominster.
Mansfield.
Marlborough (two).
New Bedford.
Northampton.
North Reading (North Reading State Sanatorium).
Shirley (F. D. Weeks Extracting Company).
Stoughton.
Taunton.
Walpole (S. Gray Company).
Westborough (Hickey-Riedeman Company) (two).
Wrentham (Wrentham State School).

MISCELLANEOUS.

Danvers.
Seekonk.

WATER SUPPLY.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to water supply: —

AGAWAM.

JULY 7, 1910.

To the Board of Water Commissioners of the Town of Agawam, Messrs. HENRY E. BODURTHA, WILLIAM H. GRANGER and DENNIS M. CROWLEY.

GENTLEMEN: — The State Board of Health received from you on June 3, 1910, the following application for its advice as to and approval of a plan of obtaining water for the supply of the inhabitants of the town of Agawam: —

The town of Agawam hereby requests the advice and approval of your Honorable Board of the purchase and distribution of water from the Little River water supply system of the city of Springfield for the use of the inhabitants of the town of Agawam for water supply purposes under the provisions of section 1 of chapter 353 of the Acts of the year 1905, said chapter having been accepted by the town at a meeting legally called and held July 28, 1905.

A plan is submitted herewith showing proposed pipe lines, and points at which connections are to be made with the Springfield pipe line.

The application is accompanied by a plan showing two systems of pipe lines: one, in the village of Feeding Hills connecting with the Little River pipe line of the city of Springfield a little less than a mile east of the Proven Mountain Reservoir, and the other, a system of pipe lines in Main, Elm, Meadow, School and River streets in and about the village of Agawam in the easterly part of the town, connecting with the West Springfield water supply system, which now supplies a part of Agawam adjacent to the village of Mittineague, at a point on Main Street near the Westfield River bridge. A letter of your engineer states that for the village of Agawam water will be taken from the West Springfield system at the point indicated above.

The Board has considered the plans presented and concludes that the use of water from the Little River water supply of the city of Springfield will be an appropriate method of providing a water supply for the village of Feeding Hills and its neighborhood in the town of Agawam, and that by diverting water from the Springfield pipe line east of the Proven Mountain Reservoir, as proposed, an ample supply of water can be obtained for all the requirements of the village.

The plan of supplying the village of Agawam and its neighborhood from the water works of the town of West Springfield, which now supplies water to a portion of the village of Mittineague in the northerly part of Agawam, appears to be a practicable and satisfactory method of providing a water supply for that section of the town of Agawam.

The Board, acting under the provisions of chapter 353 of the Acts of the year 1905, approves the purchase by the town of Agawam from the city of Springfield of water for the supply of the village of Feeding Hills from the Little River supply of said city, and approves also the purchase of water from the town of West Springfield for the supply of the village of Agawam and its neighborhood. The Board recommends that the capacity of the pipe lines be given further consideration with the view of increasing the efficiency of the works in protection against fire, by providing pipes of larger size in some of the streets.

AMESBURY.

OCT. 6, 1910.

To the Board of Water Commissioners of the Town of Amesbury.

GENTLEMEN: — The State Board of Health received from you on Oct. 5, 1910, the following application: —

> The water supply of the town of Amesbury has been found to be wholly inadequate both in quantity and quality to meet the demands for domestic use. Lack of rainfall and growing use of water are the principal reasons for this condition.
>
> The water commissioners acting under an act of the Legislature governing the water supply of the town, passed in 1906, have for a year past made great effort to secure a new supply of water. The location we are now operating upon is situated two miles from town and is in a large watershed area. An excellent supply of water has been obtained. Thirty wells have been driven varying in depth from 28 feet to 58 feet. The quantity of water from these wells will be ample to supply the town for all domestic use.
>
> As the town is in urgent need of this supply of water, and as it seems to us absolutely necessary to connect this supply with the mains in the system before cold weather sets in to save a water famine in winter, we respectfully ask your Honorable Board to pass favorably upon this petition.

The Board has caused the locality to be examined and has considered the results of investigations of various sources and of the tests made to determine the quality of the ground water in the locality in which it is proposed to locate the new works. A careful examination of the various possible sources of supply in the easterly and northerly parts of the town failing to show any source from which it was likely that an adequate supply of good water for its requirements could be obtained, tests were begun with a view to obtaining a ground water supply in the valley of the Powow River where the conditions, judging from surface indications, appeared to be more favorable than elsewhere within the limits of the town.

Tests were first made by sinking wells in the valley of the river near the town farm in an extensive area of low land bordering the river, and the results show that water could be obtained very freely from the ground in this region, but the water was found upon analysis to be very variable in character and in general of poor quality for domestic purposes.

Tests were then made by driving wells farther up the valley of the river in the neighborhood of the highway which crosses the river about three-quarters of a mile east of the outlet of Lake Attitash. Test wells driven in this region penetrated a porous stratum from which water could be pumped very freely and the water of these wells was found to be much softer than that of the wells farther down stream and of better quality than that of your present sources.

Subsequently a group of 13 wells west of the highway was connected to a steam pump and a pumping test made by pumping continuously from these wells at a rate of about 500,000 gallons per day from August 13 to August 21, inclusive. During this test the water contained a larger quantity of iron than is found in good well waters, but the quantity decreased during the test and the quality of the water improved in most respects, the results on the whole indicating that a part of the water entering the wells was derived from a territory which furnishes water containing comparatively little iron.

Further tests were then made with a view to locating wells at some place where water free from an excess of iron could be obtained. Water of good quality was obtained from a well at a point farther up the valley about a quarter of a mile southwest of the test wells, but the soil in the region about this well being composed largely of boulders, the conditions were not favorable for obtaining water from the ground by means of tubular wells. Judging from the test, however, there is no reason to doubt that a large quantity of water might be obtained from the ground if a large well were constructed in this locality.

Subsequently, other tests were made between this well and the original test wells, the results indicating that the water along the southerly side of the valley is of better quality in respect to hardness and the quantity of iron present than the water of the test wells; while farther down the valley, east of the wells, the ground water was found to be of much poorer quality, resembling the water of the wells at the town farm.

The results as a whole indicate that water of good quality for domestic purposes can probably be obtained from the ground along the southerly side of the valley of the Powow River southwest of the wells from which the pumping test was made, and it is very desirable that further tests be made in this region, especially in the locality of the test wells known as Nos. 1 and 2, by sinking a large test well and pumping from it for a sufficient time to determine the probable quality and quantity of water to be obtained there. If it is found impracticable to obtain a sufficient quantity of water for all requirements in this locality, it is advisable to sink additional wells in the rear of the Moody place, the single test well in this locality having shown favorable indications as to the quantity and quality of water likely to be obtained there. These two localities are at no great distance apart, and in case of need both sources might be utilized.

It appears, however, from the information which you have furnished as to the difficulty of obtaining an adequate quantity of water from your present sources under existing conditions, that an additional supply of water is urgently needed to meet the requirements of the town at the present time, and it further appears that the best practicable plan of securing an additional supply of water to meet an immediate emergency would be to utilize the water of the test wells in the valley of the Powow River, including those from which the recent pumping test was made, since the water of these wells is evidently safe for drinking and though affected by a slight excess of iron is of much less objectionable quality than that of the average of your present sources.

Considering the circumstances, there appears to the Board no better way of securing an adequate water supply for the requirements of the town than by utilizing for the present the test wells south of the Powow River from which the recent pumping test was made, including the other wells lately driven in this neighborhood. It is impossible to predict with certainty whether the quantity of iron present in the test wells will increase if they are used continuously as a source of water supply for the town, but considering the fact that the quantity of iron decreased during the pumping test, it is unlikely that the amount remaining in the water will be sufficient for a time at least to affect to a very noticeably unfavorable degree the quality of the water supplied to the town from these sources. It is not unlikely, moreover, that by utilizing the wells recently driven in the higher land farther from the river, water of better quality than that obtained from the test wells will be secured. If it should be found that the water on continued use contains an excessive quantity of iron or is objectionable, it is likely, judging from the tests thus far made, that wells can be located elsewhere in this neighborhood which can be operated in connection with the proposed works and which will furnish water of unobjectionable quality.

Considering the circumstances, the Board consents to the use of water from the test wells south of the Powow River about three-quarters of a mile east of the outlet of Lake Attitash or Kimball's Pond, as shown on a plan presented with your application, with the understanding that if the quantity of iron found in the water of these wells should prove to be objectionably great, further tests shall be made in this region and water taken from localities where the quantity of iron is found to be least.

AMHERST.

Nov. 3, 1910.

To the Amherst Water Company, Amherst, Mass.

GENTLEMEN: — In response to your communication relative to the use of Orient Brook as a temporary source of water supply for the town of Amherst, the State Board of Health has caused the locality to be examined by one of its engineers and samples of the water of the brook to be analyzed.

Orient Brook, at the point at which it is proposed to take the water for temporary use, has a drainage area of 9.2 square miles, a little over 6 square miles of which is included in the watershed of your regular sources of supply. Within the portion of the watershed below your present lower dam there is a considerable number of dwelling houses with outbuildings, and there is a picnic ground located just above the intake, which, however, is presumably used but little at the present season of the year. Most of the buildings within the watershed are located at a considerable distance from the streams, and there is little danger that drainage from them will pollute the water supply; but each group of buildings should be carefully inspected with a view to preventing the possible pollution of the streams therefrom, especially in times of heavy rain. The use of the picnic ground should be discontinued while Orient Brook water is being supplied to the town.

With the precautions suggested the Board approves the use of Orient Brook as a temporary source of water supply for the Amherst Water Company.

ASHLAND.

AUG. 4, 1910.

To Mr. H. E. WARREN, *Chairman of Water Supply Committee, Ashland, Mass.*

DEAR SIR: — In accordance with your application of July 15, 1910, for advice with reference to obtaining a water supply for the town of Ashland from the ground north of the Sudbury River a short distance west of the town, the Board has caused the locality to be examined by its engineer and a sample of water from a test well to be analyzed.

The results of the analysis show that the natural ground water at this place is of good quality for water supply purposes.

The material penetrated by the test well was a coarse sand and gravel which yielded water freely, and so far as can be judged from surface indications the soil is of similar character over a considerable area in this region. In the opinion of the Board the tests thus far made are sufficiently favorable to warrant a further and more thorough investigation of the practicability of obtaining an adequate quantity of good water for the town from the ground in this locality.

The Board recommends that a further investigation be made by sinking additional wells, and if the soil is found to be favorable over a considerable area the Board recommends that a pumping test be made by pumping from a group of the wells for a period of several days at a rate of as much as 75,000 gallons per day. The Board will assist you in further investigations by making the necessary analyses of water and will then advise you definitely as to the practicability of obtaining a supply of good water for Ashland from the ground as proposed.

Sept. 19, 1910.

To the Water Supply Committee of the Town of Ashland, Mr. H. E. Warren, *Chairman.*

Gentlemen: — The State Board of Health has considered your application for advice as to the practicability of obtaining a supply of good water for the town of Ashland from the ground near the Sudbury River, a short distance west of the village, and has examined the results of a pumping test made recently by pumping from a group of tubular wells in this locality.

The results of analyses of samples of water collected from time to time during the test indicate that the ground water of this region is of very good quality for the purposes of a public water supply, and the quantity of water pumped from the wells during the test indicates that with properly designed collecting works a sufficient quantity of water for the requirements of Ashland can be obtained from the ground in this locality. In the opinion of the Board, it is practicable for the town to obtain an adequate supply of good water from the ground in the neighborhood of the location of the wells from which the recent test was made. The Board recommends that the additional wells necessary for the permanent supply be located west of the wells from which the test was made and at approximately the same distance from the river.

Ashland (Well).

To the Board of Health of the Town of Ashland. June 2, 1910.

Gentlemen: — In accordance with your request an examination has been made of the well from which water is taken for the supply of the school building at the junction of Main and Union streets, and samples of the water have been analyzed. The well in question, known as the Pratt well, is located in the village of Ashland near the railroad station and there are numerous sources of pollution in its neighborhood.

The results of the analyses show that the water has at some time been badly polluted and not thoroughly purified in its subsequent passage through the ground before entering the well, and the Board recommends that the further use of this well as a source of drinking water supply for the school be discontinued.

ATTLEBOROUGH.

APRIL 7, 1910.

To the Board of Water Commissioners of the Town of Attleborough.

GENTLEMEN: — The State Board of Health received from you on Feb. 17, 1910, an application for advice as to a proposed plan of increasing the water supply of the town of Attleborough, accompanied by a report of your engineer and plans of the proposed new works.

The plans recommended provide for the construction of a storage reservoir having a capacity of about 145,000,000 gallons on a branch of the Seven Mile River about 2.5 miles above the wells from which your supply is now taken, and for using the water of this reservoir to supplement the yield of the wells in dry weather.

The well from which the supply of the town was originally taken in this locality is located about 150 feet east of the Seven Mile River and somewhat more than 250 feet from Orr's Pond. Tests in the region about this well previous to its construction showed that the soil near Orr's Pond and along the lower portion of the course of the Seven Mile River was very coarse and porous, and the well, which evidently collected a large proportion of the ground water in this region, supplied all of the requirements of the town for many years. The addition of the second well a few years ago and the filter gallery between the two wells did not increase materially the quantity of water obtainable from the ground in this region; but it was observed that in dry seasons the channel of the Seven Mile River became dry between Orr's Pond and a point several hundred feet above the wells, though water was flowing in the channel of the river farther up-stream, indicating that the water of the stream filtered into the ground at a point above the wells and probably increased their yield.

Advantage was taken of this condition to increase the yield of the wells in a dry season (1907) by pumping water from Orr's Pond into the channel of the brook in the neighborhood of the wells, and this method having been found successful, an area of about 1.78 acres of ground was cleared between the wells and along the channel of the brook near Orr's Pond, and in recent dry seasons the yield of the wells has been greatly increased by pumping water from Orr's Pond intermittently upon this area.

The quantity of water supplied by Orr's Pond, however, appears to have become nearly exhausted at the end of the year 1909, and the plan now proposed is to provide an additional supply of water whereby the flow of the brook may be maintained in dry weather and the yield of the wells still further increased by saturating the ground about them in such periods.

The Board has caused the location of the proposed reservoir to be examined by its engineer, and has examined the plans of the works now in use and the results of numerous analyses of the water of the wells. These results do not show that the water has thus far been unfavorably affected by the intermittent application of water from Orr's Pond to the ground about the wells.

If the proposed reservoir on the branch of the Seven Mile River above Washington Street, North Attleborough, should be constructed and the water used to saturate the ground about the present wells in dry seasons, it is probable that the capacity of your present sources of supply could be enlarged sufficiently to meet the requirements of the town for several years in the future. The site of the proposed reservoir is a favorable one for the purpose, and in view of the fact that the water is to be filtered, it will not be necessary to prepare the area to be flowed as carefully as would be desirable in case the water was to be used directly for water supply purposes. The quality of the water of the reservoir is likely to be affected by the presence of considerable quantities of organic matter in the earlier years of its use, especially in summer, but its character will be improved by flowing through the channel of the brook before reaching the neighborhood of the wells.

It is not practicable to predict with certainty the effect of increasing the quantity of water in the manner proposed upon the quality of the water of the wells. It is probable, however, that if the water is applied to the prepared areas of filter beds intermittently and in quantities no larger than necessary, there will be no serious deterioration in the quality of the well water. If, however, deterioration should occur, it is probable that by constructing the filtration area at a greater distance from the wells satisfactory results can be obtained. There are suitable areas along the brook above the wells which might be used for this purpose, and it is understood that a considerable area of land in this locality has already been acquired by the town. It is desirable that considerable areas of land in this region be controlled by the town in any case, in order to keep them for possible future use and prevent their occupation by buildings, drainage from which would probably affect unfavorably the quality of the water.

Considering all the circumstances, the Board is of the opinion that the proposed plan is an appropriate one for increasing the water supply of the town of Attleborough.

JULY 7, 1910.

To the Board of Water Commissioners of the Town of Attleborough.

GENTLEMEN: — The State Board of Health received from you on June 16, 1910, an application for its approval, under the provisions of chapter 468 of the Acts of the year 1910, of the location of a proposed dam and reservoir on a branch of the Seven Mile River a short distance west of Washington Street in the town of North Attleborough, accompanied by plans of the proposed works and of the lands which it is deemed necessary to acquire for developing the supply.

The Board has already considered this scheme and has advised you in a communication dated April 7, 1910, that the plan in general is, in its opinion, an appropriate one for increasing the water supply of the town of Attleborough. The Board, having examined the plans now submitted, approves the taking of water from the branch of the Seven Mile River west of Washington Street, as proposed, together with the location of the dam and reservoir which it is proposed to construct thereon, as shown upon the two plans submitted with your application, entitled respectively, one, "Attleborough Water Works. General Plan of Hoppin Hill Reservoir. Scale 1 inch=100 feet. F. A. Barbour, Eng'r," and, two, "Attleborough Water Works. Hoppin Hill Reservoir. General Plan and Profile of Dam. Scale 1 inch=50 ft. F. A. Barbour, Eng'r," the said plans being dated May, 1910.

The Board also approves the taking and use of certain lands at the site of the proposed reservoir necessary for developing the supply, shown upon a plan submitted with your application, entitled "Attleborough Water Works. Hoppin Hill Reservoir. General Plan Showing Land Takings. June 1910. Frank A. Barbour, Eng'r. David E. Makepeace, Chairman Water Comm. Scale 1 in.=100 ft."

ATTLEBOROUGH (SPRING).

OCT. 6, 1910.

To the Board of Overseers of the Poor, Attleborough, Mass., Mr. BENJAMIN P. KING, *Clerk.*

GENTLEMEN: — In response to your request of Sept. 15, 1910, for an examination of a spring on the town farm in Attleborough, which you propose to use as a source of water supply for domestic purposes at the farm, the Board has caused the spring and its surroundings to be examined and a sample of the water to be analyzed.

At the time the examination was made the spring, which is at present uncovered, contained considerable vegetable matter, but the analysis indicates that the water is likely to be of good quality for domestic purposes. The quantity of water which the spring yields at the present time is apparently quite limited, but with proper development it may furnish sufficient water for all requirements. The Board recommends that before the spring is used it be cleaned out, walled up and covered to keep out light and protect it from the entrance of surface water.

BELCHERTOWN (SPRING).

MAY 5, 1910.

To the Board of Health of the Town of Belchertown.

GENTLEMEN: — In response to a request from a resident of the town of Palmer the State Board of Health has caused an examination to be made of the water of the spring near the village of Bondsville used for the supply of the Boston & Albany railroad station and quite generally by the public in that village.

The spring is located about 100 feet south of the station and a few feet above the level of the river. The results of the analyses show that the water of the spring has at some time been considerably polluted, but subsequently quite well purified in its passage through the ground before entering the spring, and in its present condition this water is probably safe for drinking.

There are sources of pollution at no great distance from the spring, however, which probably affect its quality, and if this source is to be used the water should be examined from time to time so that, if deterioration occurs, its use may be prevented.

BOURNE (SAGAMORE).

MARCH 3, 1910.

To the Sagamore Water Company, Sagamore, Mass.

GENTLEMEN: — The State Board of Health has considered your application for advice as to taking water from the ground about a mile northwest of the village of Sagamore for the supply of Sagamore and its neighborhood, and has caused the locality to be examined by its engineer and samples of water from a number of test wells in this locality to be analyzed.

The results of the analyses indicate that water of good quality for domestic purposes can be obtained from the ground in the region indicated. The test wells penetrated various strata of sand and gravel, from which water could be pumped quite freely with a hand pump, and the indications furnished by these tests are favorable for obtaining enough water in this region for all the requirements of Sagamore and neighboring districts in the town of Bourne.

The Board recommends that you have additional wells driven in the neighborhood of the test wells, none of them, however, nearer the village or the proposed canal than test well No. 4, and that you cause a pumping test to be made by pumping from these wells for a period of at least a week at a rate of at least 200,000 gallons per day. Observations of the height of the ground water in the neighboring springs and in test wells in the vicinity of those connected with the pumps should be made during this test and samples of the water should be collected daily for analysis.

The Board will make the necessary analyses of water, and, when the results of the tests are available, will advise you as to the use of water from the ground in this region for the supply of Sagamore.

JUNE 29, 1910.

To the Sagamore Water Company, Sagamore, Mass.

GENTLEMEN: — The State Board of Health received from you on June 3, 1910, the following application for its approval of a plan of taking water for the supply of Sagamore from a system of tubular wells in Hunter's Spring Valley, so called, about a mile northwest of the village of Sagamore: —

> Acting upon your advice of March 3, 1910, the Sagamore Water Company has caused 10 additional 2½ inch wells to be driven in the Hunter's Spring Valley about 1 mile northwest of the village of Sagamore and located between test wells No. 3 and No. 4. These 10 wells have been connected with the steam pump and pumped from for seven days, an average quantity daily of about 466,000 gallons. Samples of the water pumped have been taken daily and sent to your Board for analysis, and details of the records of the pumping tests, water table elevations, etc., submitted to your engineers.
>
> Application is hereby made for the approval by your Board under chapter 618 of the Acts of the Legislature of 1908, of the location described above as a permanent source of water supply for the Sagamore Water Company.

The Board has caused the location of the wells to be examined by one of its engineers and has considered the information presented as to the depth of the wells and the character of the material through which they were sunk, and has examined the results of analyses of samples of the water collected and sent in by you during the pumping test between May 25 and June 1, 1910.

The results of the analyses show that the water is of very good quality for all the purposes of a public water supply, and the quantity of water pumped during the test, considered in connection with the height of water in the observation wells in the neighborhood during and after the test, indicates that an ample supply for all the requirements of Sagamore can be obtained from the ground in the locality indicated.

The Board, acting under the provisions of chapter 618 of the Acts of the year 1908, consents to the taking of water from the ground in the locality indicated and approves the location of the wells in that valley.

BRAINTREE.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on May 5, 1910, for preventing the pollution and securing the sanitary protection of the waters of Great Pond and its tributaries, used by the town of Braintree as a source of water supply.

CONCORD.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on April 7, 1910, for preventing the pollution and securing the sanitary protection of the waters of Nagog Pond and its tributaries, used by the town of Concord as a source of water supply.

CUMMINGTON.

DEC. 1, 1910.

To MRS. ISABELLA MELLOR, *Cummington, Mass.*

DEAR MADAM: — In response to your request of Oct. 30, 1910, for advice as to a water supply for the village of Cummington, to be taken from the ground on the south side of the Westfield River, a short distance below the bridge at the northwesterly end of the village, the Board has caused the locality to be examined by one of its engineers and has considered the information available as to the proposed source of supply and other sources in the neighborhood of the village.

It is probable that an adequate quantity of water for the requirements of the village could be obtained from the ground at some point not far below the bridge at the northwesterly end of the village, as proposed; but the ground water of this locality is likely to be polluted by the sewage discharged into the ground at the dwelling houses in the village which are located along the highway, and in order to secure water of good quality for drinking it will be necessary to locate the wells at some point at a greater distance from dwelling houses.

The examinations of the locality indicate that water of good quality might be obtained on the north side of the river approximately midway between the two bridges, where the ground water would not be likely to be affected by the drainage from dwelling houses. It is impracticable to tell in the absence of tests whether a sufficient quantity of water can be obtained in this locality for the requirements of the village, but, judging from the surface indications, the conditions appear to be favorable for obtaining a sufficient quantity for all requirements in this locality.

It is possible also that a ground water supply might be obtained in the valley of Meadow Brook at a point a little over a mile north of the village and north of the second highway crossing above the mouth of this stream. The conditions here, judging from surface indications, appear to be favorable for obtaining water from the ground in the neighborhood of the brook by means of wells or other suitable collecting works. If a water supply should be obtained in this locality it could probably be delivered to the village by gravity, and, while the cost of the works might be greater in the beginning than the cost of a supply obtained from the ground in the neighborhood of the village, the cost of maintenance of the gravity system would be less.

The Board recommends that a further test be made by sinking wells at the locations mentioned, to determine the character of the soil and the probable quality of the water to be obtained. The Board will assist you in the further investigations, if you so request, by making the necessary analyses of water, and will give you further advice when the results of further tests are available.

DALTON (DALTON FIRE DISTRICT).

JUNE 2, 1910.

To the Water Commissioners of the Dalton Fire District, Mr. FREDERICK G. CRANE, *Chairman.*

GENTLEMEN: — In response to your request of May 14, 1910, for advice as to an additional water supply for the Dalton Fire District, to be taken from Cady Brook in the town of Hinsdale, the Board has caused the present and proposed sources of water supply to be examined by one of its engineers and samples of the water to be analyzed.

The watershed of Cady Brook above the point at which it enters the Windsor Reservoir comprises about 4.1 square miles of very sparsely settled territory lying in the towns of Hinsdale, Peru and Windsor. Within the limits of this watershed there are eleven dwelling houses with outbuildings, and it appears that seven of these houses have already been purchased and are now controlled by the Dalton Fire District. Among the houses thus acquired are included nearly all of those situated close to the main brook or its tributaries, and danger of pollution to the brook or its tributaries from the remaining houses on the watershed can probably be prevented without serious difficulty.

The results of analyses of the water of Cady Brook show that while it is slightly colored by vegetable matter it is of good quality for domestic purposes and differs very little in character from that of your present sources of supply. The natural flow of Cady Brook if used in connection with your present sources will probably be sufficient to meet the present needs of the district, and there appear to be sites at which reservoirs can be constructed in the valley of the stream to increase the yield of the sources when a further supply becomes necessary. Your present plan does not, however, designate any location for a dam on the stream.

The Board, having considered the plan of using Cady Brook as an additional source of water supply for the Dalton Fire District, advises and approves the taking and use of said brook under the provisions of chapter 409 of the Acts of the year 1910.

DRACUT (TYNG'S POND).

MAY 19, 1910.

To the Board of Health of the Town of Dracut.

GENTLEMEN: —An examination of the resort known as Lakeside near the easterly end of Tyng's Pond shows that the water supply is taken directly from the lake, and that the sewage from this resort is discharged in such a way that it finds its way into the lake within a short distance of the intake.

In the opinion of the Board, it is essential for the adequate protection of the health of those resorting to this place that a supply of good drinking water be provided from some suitable source. The lake is not a safe source from which to take water for drinking.

Provision should also be made for the proper disposal of the sewage so that it will not create a nuisance or pollute the water of the lake.

MAY 19, 1910.

To the Boston & Northern Street Railway Company, Lowell, Mass.

GENTLEMEN: —Complaint having been made to this Board of the unsatisfactory sanitary conditions at the resort known as Lakeview on Tyng's Pond in the town of Dracut, which, the Board is informed, is controlled by your corporation, the Board has caused an inspection of the locality to be made by one of its engineers with special reference to the condition of the water supply and means provided for the disposal of sewage.

From this examination it appears that the water supply at this resort is taken in part from the pond a short distance from shore, near one of the main buildings, and in part from a system of tubular wells in a swamp in the eastern part of the grounds. The Board is informed that the lake water is pumped into a tank, having a capacity of about 5,000 gallons, each morning and is subsequently used for various purposes, including sprinkling the drives and walks, washing floors, etc. Water is then pumped from the group of tubular wells in the swamp in the rear of the theatre into the same tank.

Analyses of the water show that that which is drawn from the wells, while affected by an excess of iron, is probably safe for drinking, but the water which is drawn from the pond is very badly polluted. There is no doubt that with the present arrangement, by which water is drawn a part of the time from the pond and at other times from the wells and distributed through the same tank and pipes, the drinking water supplied to the park is polluted to a greater or less extent and unsafe for drinking.

The Board recommends that the drawing of water from the pond, and its distribution through the same pipe system as the water supplied for drinking and cooking, be discontinued at once. If the pond water is used at all in the buildings or upon the grounds, it should be supplied in such a way that there will be no danger that it may be used for drinking or cooking.

The well water, while affected, as already stated, by an excess of iron, is probably not seriously polluted at the present time, but it is probable that with continued use the quantity of iron in this water will increase so that it will become very objectionable for drinking and other purposes.

It is probable that wells can be so located at some point in this region that an ample supply of good water can be obtained for the requirements of the park, which will not be polluted or affected by an excess of iron. The Board recommends that tests be made without delay with a view to securing a supply of water of good quality and that such a supply be provided as soon as possible to replace the water of the wells which contains an excess of iron.

It also appears that the provision for sanitaries and similar conveniences at this park is entirely inadequate for the purposes, and that a serious nuisance is created there at times in the summer season. The Board recommends that adequate and suitable sanitaries be provided, and that at the same time provision be made for the disposal of the sewage in such a way that it will not create a nuisance or pollute the waters of the pond.

The Board is informed that the resort known as Mountain Rock, on the northwesterly side of the pond, is also under the control of your company. This resort is not apparently used to a very considerable extent, but it does not appear that any provision has been made for a supply of drinking water except by taking water from the lake. The lake water is exposed to pollution by the sewage from this resort, and if this resort is to be used during the coming year a supply of good water for drinking should be provided.

FAIRHAVEN (WELLS).

DEC. 14, 1910.

To the Board of Health of the Town of Fairhaven.

GENTLEMEN: — In accordance with your request the Board has caused an examination to be made of certain wells near the easterly limits of the village of Fairhaven, and samples of the waters of the wells to be analyzed.

The wells in question are located south of Center Street near low marshy ground, in close proximity to dwelling houses and other sources of pollution. The results of the analyses show that the waters of all of the wells are so grossly polluted that their use for drinking should be prevented forthwith. Suitable drinking water cannot be obtained in this locality from wells, but a public water supply pipe is not far away.

The Board learns that the sanitary conditions under and around these houses render them unfit for human habitation; and in the opinion of the Board such use of them should not be made while the ground is saturated and water stands in the cellars.

This low land should not be used for dwellings until the grade is raised well above the ground water and the cellars can be drained.

GARDNER.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on Jan. 6, 1910, for preventing the pollution and securing the sanitary protection of the waters of Crystal Lake and Perley Brook Reservoir and their tributaries, used by the town of Gardner as sources of water supply.

GRANVILLE.

AUG. 1, 1910.

To the Granville Centre Water Company, Granville, Mass., Mr. J. M. STEVENSON, *President.*

GENTLEMEN: — In response to your application of July 7, 1910, for the approval by the State Board of Health under the provisions of chapter 486 of the Acts of the year 1910 of the use as a source of water supply in the town of Granville of the Downey Springs, so called, located north of the highway leading from Granville Centre to West Granville and west of the highway known as North Lane, the Board has caused the locality to be examined by one of its engineers and has examined the plans presented. These plans show the location of a proposed storage reservoir into which the water of the springs is to be collected and from which it is to be distributed to the village of Granville Centre.

The analyses of the water of the Downey Springs show that it is of very good quality for the purposes of a public water supply. The natural flow of the springs has been ascertained to be about 6,000 gallons per day in very dry weather, but this quantity can apparently be increased by diverting into the proposed reservoir the flow of other springs in the vicinity of the main sources, and with reasonable economy in the use of water a sufficient quantity could probably be obtained from the springs available in this locality to supply the present needs of the village of Granville Centre.

The Board, under the provisions of chapter 486 of the Acts of the year 1910, approves the plan of acquiring the Downey Springs as a source of water supply, and approves the location of the proposed reservoir as shown on the plans submitted with your application.

Your petition also requests approval of the acquirement by the Granville Centre Water Company of —

> such portions of the Downey and Church farms, so called, located north of the West Granville road and west of said North Lane as may be necessary for a source of water supply or preserving the quality of the water therein.

The act by which the Granville Centre Water Company is established does not appear to require the approval of the State Board of Health of the taking of such lands as may be necessary for the development of the sources of water supply. If, in addition to the takings for this purpose, it is desired to acquire further lands for the protection of the quality of the water, a plan and description showing definitely the lands which it is proposed to acquire for that purpose should be submitted to the Board.

GREENFIELD (FIRE DISTRICT NO. 1).

SEPT. 1, 1910.

To the Board of Water Commissioners of Fire District No. 1 in the Town of Greenfield.

GENTLEMEN: — The State Board of Health received from you on Aug. 4, 1910, an application for the approval of the taking of a certain parcel of land on Rocky Mountain in the town of Greenfield for the purpose of constructing and maintaining thereon a reservoir to be used in connection with the water supply system of said district. The application was accompanied by plans showing the location of the proposed reservoir, the area of land to be acquired for the purpose, which is included in lands now controlled by the town of Greenfield for park purposes, and by reports of your engineers describing the proposed reservoir.

The plan provides for the construction of a covered masonry distributing reservoir on Rocky Mountain, with its center about 300 feet east of the proposed street to be known as Mountain Road, with a right of way 25 feet in width from the reservoir to Mountain Road. The reservoir is to be constructed partly in excavation and partly in embankment, and the area of land which it is proposed to acquire amounts to 1.78 acres.

The Board has caused the locality to be examined by its engineer and has examined the information presented, and concludes that the area to be taken is necessary and reasonable for the construction and maintenance of the proposed reservoir and access thereto; and the Board approves the taking of the land shown upon the plan filed with the application, entitled "Fire District No. 1 of Greenfield, Mass. Map Showing Location of Rocky Mountain Reservoir on Park Land. Scale 1″ = 50′. July 1910."

HADLEY (HADLEY WATER SUPPLY DISTRICT).

APRIL 7, 1910.

To the Board of Commissioners of the Hadley Water Supply District, Messrs. G. FRED PELISSIER, A. J. RANDALL and HOMER F. COOK.

GENTLEMEN: — The State Board of Health has considered your communication of March 9, 1910, stating that you have constructed a reservoir on Harts Brook, about 1,700 feet below the reservoir constructed on that stream in 1905 and at about 60 feet lower level, and that you desire the approval of the location of this reservoir under the provisions of chapter 146 of the Acts of the year 1905.

The plan of constructing the reservoir at this location to increase the sources of water supply of the district was considered by the Board last year, but, it appearing that there was a doubt as to the necessity and desirability of constructing this reservoir at that time, the Board recommended further examinations to determine the feasibility of stopping the leaks in the upper reservoir, and at the same time recommended that the quantity of water used by the town be carefully measured.

The watershed of the new reservoir is uninhabited and the water is of good quality for domestic purposes. The pressure that will be obtained from this reservoir will be considerably less than from the upper reservoir, but will probably be sufficient for present requirements. It will not be essential to use the new reservoir except in periods of dry weather, and, considering the circumstances, the Board approves the location, under the provisions of chapter 146 of the Acts of the year 1905.

The Board again recommends that you provide a suitable meter or other means for measuring accurately the quantity of water supplied to the town from the reservoirs on Harts Brook, since the information furnished by careful records of the consumption of water is likely to be of much value in the further development of your water supply.

HARDWICK (GILBERTVILLE).

Nov. 3, 1910.

To the George H. Gilbert Manufacturing Company, Gilbertville, Mass.

GENTLEMEN: — In response to your request for an examination of the water of certain tubular wells recently driven near the village of Gilbertville and advice as to the use of these waters for the supply of the village, the State Board of Health has caused the wells and their surroundings to be examined and samples of the water to be analyzed.

The wells, which are numbered 2 and 3, are each 6 inches in diameter and were bored mostly in rock, their depth being respectively 197 and 128 feet. They are located on the mountain side, west of the Ware River, a short distance north of the boundary line between Ware and Hardwick. Analyses of the waters of these wells show that the hardness is greater than desirable, but in other respects the water is of good quality for domestic purposes. The quantity of water which these sources have been found to yield is limited, and it is not likely to be sufficient for the requirements of the village at all times.

An examination has also been made of the waters of certain other wells and springs in the neighborhood of the village, which are available for use or are already used as sources of domestic water supply. One of these, the New Braintree springs, situated in the town of New Braintree, on the easterly side of the Ware River in the neighborhood of Gilbertville, supplies water of very good quality for domestic purposes.

The "Lighthouse well," so called, located on the westerly side of the Ware River in the northerly part of Gilbertville, shows some evidence of previous pollution, doubtless caused by buildings in the neighborhood of the well, but when examined the water was being quite thoroughly purified in its passage through the ground before entering the well, and under present conditions this water is probably safe for drinking.

The water of tubular well No. 1, located north of the river near the upper end of the village, was found to be excessively hard and unfit for domestic uses.

It is very important, in the opinion of the Board, that an adequate supply of good water of sufficient quantity to meet all requirements should be provided for the use of this village as soon as practicable.

HOLYOKE.

SEPT. 28, 1910.

To Mr. A. E. PICKUP, *Registrar, Board of Water Commissioners, Holyoke, Mass.*

DEAR SIR: — In relation to the use of water from the Fomer watershed, referred to in your letter of September 3, I beg to inform you that the question has been investigated by representatives of this Board, who report that the conditions obtaining at the lumber camps in the above mentioned region have been found to be most unsanitary.

The use of water from this supply is to be strongly condemned. As to the remedy to be applied to this situation, I would refer you to rules 3 and 5 of the rules and regulations made by this Board on Aug. 6, 1908, at the request of the Holyoke water board, for the protection of the water supply of that city. These rules give your Board ample power to deal with the situation and should be put in force immediately.

NOV. 3, 1910.

To the Board of Water Commissioners of the City of Holyoke.

GENTLEMEN: — The State Board of Health received from you on Oct. 20, 1910, the following application for advice relative to the use of the water from the Manhan River watershed: —

> We wish to solicit your advice as to what should be done relative to the turning on of our Fomer and High Service reservoirs, both of which have been out of commission since the 13th of August last, on account of the supposed typhoid outbreak on the Fomer watershed.
>
> Since that time the Fomer water is being wasted and our High Service Reservoir, into which the Fomer pipe line was then discharging, is shut off. The very dry season we are having is now plainly showing its effect upon our storage and there is no knowing how long this weather may continue. Under such conditions it seems advisable that we should have the use of both the Fomer and the High Service water as soon as possible, especially the Fomer water, which is now going to waste. We could divert and waste the Tucker Brook, upon whose watershed the supposed typhoid has occurred, but if we do this, it practically means that half the water on the watershed is going to be lost, which is rather a serious matter with a water famine confronting us.
>
> The cost of diverting the Tucker Brook we do not consider for a moment, but if anything could be done to save this water, it seems such would be the advisable course to pursue.
>
> There are from 50 to 60 people living along the Fomer pipe line who have been taking water from the pipe during the typhoid outbreak and since, yet none of them have been taken ill.
>
> It seems to us that the High Service Reservoir could be turned on and

that the Fomer pipe line could be discharged into the southerly end of Ashley Reservoir at this time without any risk. In the latter case the water has to travel about 1½ miles through Ashley and the Wright Reservoir before it reaches the intake or pipe system.

Under these conditions the risk of conveying any pollution that might cause trouble would be very slight indeed, and at all events if such was in the water, the effect of it should appear first amongst those drawing water from the pipe line.

There is no one now working at the lumber camps where the sickness occurred and we are having the place thoroughly cleaned up.

Your early advice in the matter will be greatly appreciated, as we are beginning to worry somewhat about having an adequate supply to carry us through the winter, provided the weather continues dry; and still more through next summer, provided we would not be able to fill our reservoirs in the spring.

The Board has caused the watershed to be examined by one of its engineers and samples of water from Wright and Ashley ponds, the High Service Reservoir and various points along the feeders of the Fomer or Manhan River supply to be analyzed, both chemically and bacterially.

The results of the analyses show that the number of bacteria in Wright and Ashley ponds and in the High Service Reservoir is low and there was no evidence at the time this examination was made of injurious contamination. In their general features, as shown by the chemical analyses, the waters of Wright and Ashley ponds contain more organic matter than is usually the case at this season of the year, possibly on account of the fact that these waters have been drawn to a very low level. The condition of the High Service Reservoir, so far as the chemical analyses show, is about as usual. Judging from these analyses, it is probable that the water of the High Service Reservoir can be used with safety for the supply of the city at the present time.

The part of the area drained by Tucker Brook where dangerous disease was found to exist, and upon which pollution dangerous to the water supply is now being removed, can probably be rendered safe in the course of a month after you have it thoroughly cleaned up. If you now divert the water of Tucker Brook from Fomer Reservoir and waste it during this period, and after its diversion draw from Fomer Reservoir, which will then receive water from about two-thirds of its drainage area, it is probable that the water from Fomer Reservoir could be turned into the southerly end of Ashley Pond and thence after flowing through Wright and Ashley ponds be supplied to the city without danger to the public health.

The Board further recommends that a thorough inspection of the sanitary conditions in this and the other watersheds be instituted and maintained, and that the rules established for the sanitary protection of the Manhan supply be strictly enforced.

HUDSON.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on July 7, 1910, for preventing the pollution and securing the sanitary protection of the waters of Gates Pond and its tributaries, used by the town of Hudson as a source of water supply.

HUNTINGTON (HUNTINGTON FIRE DISTRICT).

AUG. 4, 1910.

To the Board of Water Commissioners of the Huntington Fire District, Huntington, Mass.

GENTLEMEN: — The State Board of Health received from you on July 25, 1910, through your town counsel, the following communication relative to the water supply of Huntington, in which you apply for the approval of the use of Cook or Roaring Brook as a source of water supply for the town: —

> . . . The water situation here demands immediate attention. We are practically without water. The pumping station and system of wells established about two years ago are practically worthless in so far as furnishing any reasonable amount of water. We feel, and the town is unanimous in supporting this feeling, that more water must be obtained and that at the earliest possible moment. For some years we have had similar shortage through four months; each year it has grown worse; and this in spite of the pumping station and wells as an auxiliary supply.
>
> Application is hereby made for your approval of either Cook or Roaring brook as a supply. We do this that the matter may receive your consideration and advice. As stated above the situation here demands immediate attention and we hope you will be able to help us out.

In response to this application the Board has caused the locality to be examined by one of its engineers and has considered the available information relative to the yield of the present and proposed sources and the character of the water obtainable therefrom.

The sources from which you desire to take an additional supply, as mentioned in your application, appear to be the same stream, which is marked Roaring Brook on the State map. This stream enters the Westfield River opposite the mouth of Cold Brook, your present source of supply during most of the year, and could readily be utilized by a comparatively short extension of your present pipe line. The watershed of Cook Brook was carefully examined three years ago with a view to its use as a source of water supply for Huntington, and you were then advised concerning it as follows: —

> The water of Cook Brook, the proposed source of auxiliary supply, is naturally of good quality, but there are many dwelling houses with their outbuildings within this watershed, and the stream is greatly exposed to danger of pollution. In the opinion of the Board, its waters could not with safety be used for drinking, and the Board does not approve the use of that source as an auxiliary water supply for the town of Huntington.

From the information which you have furnished the assistant engineer of the Board, it appears that there is practically no change in the conditions affecting the quality of the water from this watershed. There are many dwelling houses within the watershed which, with their outbuildings, are so situated with reference to the stream or its tributaries that foul drainage from sink drains, privies or barn-yards may find its way directly to the brook; and the highway in the lower part of the watershed follows the stream closely for a mile and a half above the point at which the water would be taken. Under these circumstances there can be no question that the use of this water for domestic purposes might cause sickness. Water supplies of similar character have been the source of very serious epidemics, and under the circumstances the Board does not approve the use of this stream as a source of domestic water supply.

It appears from the information available to the Board that the reservoir on Cold Brook is empty and that the flow of the stream has fallen as low as 15,000 gallons per day. An examination of the tubular wells and a short test of their yield indicate that they are furnishing at the present time about 50,000 gallons per day. The two sources together at this time are furnishing about 65,000 gallons per day, or approximately 60 gallons per person for the population in the main village, assuming that the population is approximately 1,100. It appears that none of the water supplied to the town is metered, and it is likely that a considerable quantity is lost by waste and leakage from the mains and service pipes. If the quantity of water used in the town of Huntington were no greater in proportion to the population than is found necessary for the supply of towns in which care is taken to prevent unnecessary use and waste of water, a quantity amounting to 50,000 gallons per day would be ample for present needs.

The conditions about the tubular wells from which the auxiliary supply is taken in the summer season are very favorable for obtaining water freely from the ground, and the wells now in use supply water of excellent quality for domestic purposes. The quantity now obtained is nearly sufficient for present needs, and it is very probable that, if the wells now in use were carefully examined by someone of the necessary experience in such matters, they could be put in condition to yield a larger quantity of water. In any case there is no reason to doubt that by driving a few additional wells in suitable locations in the neighborhood of the pumping station an ample quantity of water can be obtained in this locality for the requirements of the town in dry weather. There does not appear to the Board to be any other source from which an adequate supply of good water which is safe for drinking can be obtained in less time or at a smaller cost.

The Board recommends that you cause additional wells to be driven as soon as practicable, and that, as soon as additional wells are available, the present wells be carefully examined and such improvements made as may be found necessary to increase their yield. This work can be done in a very short time if it is begun without delay, and with economy in the use of water until additional wells can be driven it will be unnecessary to introduce into the water pipes of the town any water which is unsafe for drinking.

Nov. 3, 1910.

To the Board of Water Commissioners of the Huntington Fire District, Huntington, Mass.

GENTLEMEN: — In response to a request from a member of your board for an examination of the water of a spring located a little over 1,000 feet west of your pumping station near the Westfield River, the State Board of Health has caused the spring to be examined by one of its engineers and samples of the water to be analyzed.

The spring is a basin of ground water of irregular shape which at the time it was examined had a length of about 150 feet, an average width of about 12 feet, and an average depth of somewhat more than a foot. The overflow was then running through a clearly defined channel to the river, which is distant about 450 feet from the basin. At the time this examination was made the basin was being supplied by water passing through the ground, but an examination of its surroundings showed that at times it probably receives a flow of surface water from a small stream which enters it from the south and evidently receives drainage from a considerable length of the Boston & Albany railroad. It is also probably affected by river water at times of high flow. Under the circumstances the spring cannot, in the opinion of the Board, be regarded as a safe source from which to take water directly for domestic purposes.

There appears to be a considerable flow of ground water from the gravelly lands in the region about your present wells, and there is no reason to doubt that an ample supply of good water for the requirements of Huntington can be obtained from the ground in this region by extending the present collecting system, as recommended by the Board in its communication of Aug. 4, 1910.

HYDE PARK.

MAY 19, 1910.

To the Board of Health of the Town of Hyde Park, MR. JAMES G. BOLLES, *Clerk.*

GENTLEMEN: — The State Board of Health has considered your application of March 31, 1910, for information as regards the condition of the water furnished the town of Hyde Park in its relation to the public health, has caused the localities from which the present supply is taken to be examined and has considered the results of numerous analyses of the water from these sources.

The original source of water supply of the town used first in 1885 was a group of tubular wells located near the eastern bank of the Neponset River a short distance above the densely populated portion of the town, increased subsequently by the addition of various other groups of wells in the same general locality. From time to time, in response to applications from the authorities of the water company or of the towns of Hyde Park or Milton, to which the water was supplied, the Board has examined these various sources and has advised concerning the condition of the water. In the course of these examinations the condition of some of the wells or groups of wells was found to be objectionable, and the use of many of the original wells was long ago discontinued and others substituted therefor.

Notwithstanding these changes the quality of the water continued to deteriorate quite steadily, and in 1899 the Board advised that a supply of water be introduced from a new source, and recommended changes in the wells near the Neponset River, in order that the use of wells furnishing water of suspicious quality might be discontinued.

A new supply was introduced in 1900 from a group of wells in the valley of Mother Brook near the boundary line between Hyde Park and Dedham, but the quantity of water drawn from this new source during 1900 and 1901 was small compared with the quantity which has been drawn from these wells since that time. Early in 1902 the draught from the new source was greatly increased, and later on in that year, when the supply of water to Milton was discontinued, the draught from the wells near the Neponset River was greatly reduced.

These changes and certain improvements which were made at this time in the Neponset River wells were followed by a marked improvement in the quality of the water, but a gradual increase in the draught of water from these wells in the years 1903, 1904 and 1905 was accompanied by a gradual deterioration in its quality. In the next three years the draught of water was quite constant, and its quality showed little change, but in the dry years 1908 and 1909 a further very marked deterioration occurred, and the water during these years was of very much poorer quality than at any previous time.

It has long been known that a large portion of the water which enters the Neponset River wells is derived by filtration through the ground from the river. This stream is very badly polluted and there is little doubt that if the use of the wells is continued the quality of the water will grow worse unless the quantity drawn from these sources shall be very greatly reduced. In its present condition the water from these wells cannot, in the opinion of the Board, be considered safe for drinking.

The water which enters the Mother Brook wells has since the beginning shown evidence of previous pollution, but has been subsequently quite well purified in its passage through the ground before entering the wells, and no serious deterioration has been noted in its character since the use of this water was begun. The quantity of water taken from these wells is much greater than that which has been drawn from the wells near the Neponset River, but, judging from the information which has been furnished to the Board, it is unlikely that a much greater quantity of water can be drawn from these wells than has been drawn during the past two years; and in any case it is improbable that a sufficient increase in the quantity of water available for the town can be made by increasing the draught from these wells to make it practicable to reduce materially the draught from the wells near the Neponset River.

The region about the Mother Brook wells is quite densely populated, and it is impracticable to extend the collecting system in this valley sufficiently to obtain a materially larger supply of water without locating wells in close proximity to populated areas, where the water will be likely to be polluted.

Under the circumstances, it is improbable that a sufficient increase in the supply of water can be obtained from the Mother Brook wells to make it practicable to reduce the draught from wells near the Neponset River to such an extent that those sources may continue to be used with safety.

The town has paid for the right to take water from the Metropolitan Water District and it will probably be practicable to obtain water from the metropolitan system more promptly and at less expense than in any other way. Considering the circumstances, the Board recommends that a supply of water be secured from the metropolitan water system and the use of water from the wells near the Neponset River discontinued.

The water of the wells in the valley of Mother Brook can continue to be used with safety while its quality remains as at present, but if it is found advantageous to continue the use of these wells, after a supply of water from the Metropolitan Water District becomes available, it is important that frequent analyses of the water be made and its use discontinued in case deterioration occurs.

DEC. 1, 1910.

To the Board of Health of the Town of Hyde Park.

GENTLEMEN: — An investigation as to the occurrence of an unusual number of cases of typhoid fever in Hyde Park during the present year, and especially in the month of October, while not yet completed, points somewhat strongly to the public water supply as the probable source of infection.

During the past year about two-thirds of the supply of the town has been drawn from the group of tubular wells near Mother Brook and the remainder from the groups of wells near the Neponset River.

The water of the Neponset River wells has become so polluted as to be unfit to be used for domestic purposes, and its use should be discontinued. The degree of its pollution has followed dangerously near to and coincident with the degree of pollution of Neponset River and the prevalence of typhoid fever has been coincident with their common pollution.

The water of the new wells situated near Mother Brook does not show by chemical analysis pollution beyond that of many driven well supplies, and its quality does not fluctuate in general with that of Mother Brook, but there are some local conditions that render this water suspicious. The wells situated nearest to privies on Paradise Lane give water more polluted than those farther away. The water from Mother Brook sometimes flows over land surrounding the wells and enters springs which are probably feeders of some of the wells. After a heavy rain in September last the water from these wells contained a much larger number of bacteria than usual, and there were some bacteria characteristic of sewage.

In view of these conditions your recommendation that the water of the public water supply be boiled before drinking should, in the opinion of the Board, be continued.

The Board recommends that an adequate supply of good water be secured as soon as possible.

The town, as you have already been advised in a previous communication, has paid for the right to take water from the Metropolitan Water District, and it would probably be practicable to obtain water from the metropolitan system more promptly and at less expense than in any other way.

LOWELL.

To the Water Board of the City of Lowell. JULY 7, 1910.

GENTLEMEN: — The State Board of Health has considered your application for advice as to taking a certain additional area of land adjacent to the Pawtucket Boulevard with a view to extending the system of tubular wells from which the supply of the city is obtained, and has caused the locality to be examined by one of its engineers and samples of water from test wells near the southerly limit of the area to be analyzed.

The area which it is proposed to take is located along the northerly side of the Boulevard west of East Avenue and about opposite the lower Boulevard pumping station, so called. The results of analyses of water from the test wells in this area show that the water, while it has at some time been polluted, has subsequently been well purified in its passage through the ground before entering the wells, and the quantity of organic matter present was low. The pollution of the water was probably caused by the occupation of this locality by refreshment booths and its use for various purposes during the automobile races in September of last year. As the sources of pollution have been removed, it is probable that their effects will gradually disappear, and if water is taken from the ground 200 feet or more north of the Boulevard, it is unlikely that it will be affected injuriously by the pollution caused by the use of the territory near the highway in the manner described.

Regarding the quantity of water that can be obtained from this territory, no definite estimate can be given. The test wells penetrated a porous stratum from which water could be pumped very freely, and these and other tests in the neighborhood indicate that water can probably be obtained freely from the ground in the area which it is proposed to take.

The quality of the water supplied to the city from the present wells near the Boulevard has shown some deterioration in the last two years, and it is probable that some of the wells now in use furnish water of inferior quality to others. By constructing a system of additional wells in the lands which it is now proposed to take and in other areas north of the present wells, it is likely that a considerable increase can be secured in the amount of ground water available, making it practicable to examine carefully the wells of the present system and discontinue any which are found to furnish an inferior quality of water.

In view of the circumstances the Board advises that the land mentioned in your application, amounting to about 10.8 acres, be acquired for the purpose of enlarging and improving the water supply of the city.

It will probably be found advantageous to extend the driven well system in future in the areas north of the Boulevard and of the wells from which the supply is now drawn, but if the area north of the land now owned by the city for water supply purposes, including the area which it is now proposed to acquire, should become populated, it is likely that the effect of the occupation of these lands upon the character of the well water would be unfavorable. It is practicable to protect the quality of the ground water in this region from danger of pollution by acquiring lands for a considerable distance north and east of the wells and preventing their occupation, and these lands can doubtless be acquired at much less cost at the present time or in the immediate future than after they have become occupied by dwellings. The water supply of the city of Lowell is likely to be taken from the ground in this region for many years in the future, and it is very important, in the opinion of the Board, that such measures be taken as may be necessary to protect it from danger of pollution.

LYNN.

To the Public Water Board of the City of Lynn. APRIL 7, 1910.

GENTLEMEN: — The State Board of Health received from you on Jan. 26, 1910, a communication stating that the city government of Lynn, on Jan. 24, 1910, approved and endorsed the recommendations of your board relative to the treatment and purification of the public water supply of the city by the installation of a mechanical filtration system.

Your report of Jan. 21, 1910, contains the following recommendations: —

> With the distinct understanding that the best chemical-mechanical plant must for safety always be under the care of a competent expert, that daily analyses must be made of the water, the best safeguards and checks against unskilled handling provided and our storage facilities utilized to their fullest extent, the following plan combining long storage and purification by chemical-mechanical means is now recommended. In this plan it is proposed to not only filter all of the water but to improve the storage conditions by the installation of pumps at Montrose, on the Saugus River and at Hawkes Pond, discharging into the northern arm of Walden Pond, thus not only getting additional storage and the opportunity of taking water from Saugus River at any time but making it impossible, in any practicable way, for water to reach the filters until it has been stored for a long time.
>
> If this general plan is approved by the council and the State Board of Health, as required by the act, detailed plans will be prepared and submitted

to the council and the State Board for final examination and approval, as the act also required.

Without plans of the work and method of treatment it is not practicable to make accurate statements of the results, but from experience and experiments made elsewhere it is probable that the cost of maintaining an efficient plant will be enough more than the cost of maintaining good slow sand filters to make the entire cost of construction and maintenance of the chemical-mechanical filters greater than that of the slow sand filters.

In the removal of color the chemical-mechanical filter has some advantage, but the result from either process with Lynn water would probably be entirely satisfactory. In the removal of disagreeable tastes and odors a chemical-mechanical filter would not be as efficient as a slow sand filter. With such tastes and odors as have been experienced during the past year the proposed process might be satisfactory; but the increasing amount of Saugus River water to be added to the reservoirs is likely to increase the growth of organisms which produce the disagreeable tastes and odors to such an extent that mechanical filters will not remove them.

The efficiency in removal of bacteria of the best chemical-mechanical filters is not as high or as steady as of the best slow sand filters.

Complaints are made of excessive corrosion of iron pipes and copper tanks in which is used filtered water from well managed chemical-mechanical filters, which effect appears to be most serious with soft, dark waters, like those of Lynn. This is thought to be due to the increase in carbonic acid in such waters due to filtration with coagulants.

With these results we have reason to expect active corrosion of steam boilers and water containing so much iron rust as to be very objectionable for domestic use.

We find no such general improvement in the health of the community from using the best regulated mechanical filters as when good slow sand filters have been used.

While purification by chemical-mechanical filters remains in its present experimental condition, with very objectionable results unremoved, we are unable to advise its adoption by the city of Lynn.

Nov. 3, 1910.

To the Public Water Board of the City of Lynn.

GENTLEMEN: — The State Board of Health received on Oct. 6, 1910, plans and specifications of a mechanical filtration plant proposed for construction at Lynn, together with copies of the letters and communications of George W. Fuller, C.E., to the engineer and water board of the city of Lynn.

These communications do not indicate that the engineer, Mr. Fuller, advised the officials of Lynn that a mechanical filter plant would best serve the city in rendering the water supply satisfactory, but that he presents "a statement containing the essential features of a mechanical filter plant, for which you instructed me to prepare plans and specifications in conformity with chapter 658 of the Acts of 1910."

These plans as outlined present the usual type of mechanical filter plant as constructed at the present time, with modifications due to this location and with the addition of the recently discovered bleaching powder treatment. They leave many details of construction apparently to the discretion of the contractor or the mechanical filter company successful in its bid for construction.

The mode of construction of the apparatus for handling and filtration, by the method decided upon by the city of Lynn, of the public water supply of the city is of much less importance in the view of this Board, at the present time, than the probable quality of the effluent from said filtering plant.

The Board concludes from its investigations and its experiments upon the Lynn water that the proposed treatment will probably fail to remove the objectionable tastes and odors arising in the Lynn water after Saugus River and Ipswich River waters are added. The proposed treatment is further likely to increase the growth of organisms in the open distributing reservoir and there increase the disagreeable tastes and odors of the water distributed to consumers.

The experiments of the Board with Lynn water, treated as proposed, indicate that chemical conditions will be introduced in the water supplied to consumers that will cause corrosion of metals or increase of hardness or both, to an objectionable degree; and we find that waters treated as proposed do not cause the general improvement in the health of the community that has been experienced when good slow sand filters have been used.

The treatment proposed here is an experiment like others that have been tried, but when made with water similar to that of Lynn we know of no cases where the result has been such that we could advise the city of Lynn to depend upon it for producing a satisfactory water supply.

LYNN (CREIGHTON BROTHERS).

OCT. 6, 1910.

To the Board of Health of the City of Lynn, MR. GUSTAVUS A. BADGER, *Clerk.*

GENTLEMEN: — The State Board of Health received from you on Sept. 2, 1910, the following communication requesting an examination of the water supplied to the factory of Creighton Bros. in Lynn: —

> That the employees in the factory of Creighton Bros., 29 Willow Street, Lynn, have been affected presumably by the drinking water supplied to that factory from a private spring in Lynn. The firm thinks that the sickness among the employees is due to this water and would like an early analysis to find out if the water is polluted. The water is from the Bassett Spring in Swampscott. He also gets a supplementary supply in the factory from a well, unknown whether it is artesian or not. He would also like to have an analysis made of this water, as 600 or 700 hands are employed in the factory.
>
> The Lynn board of health considers it of sufficient importance to call for your immediate attention.

The Board is informed that at this factory the drinking water for the use of the office is supplied by one of the spring water companies, while the water supplied to the operatives is taken from two driven wells in the basement of the building. It also appears that at about the time your application was made a change was made in the spring water supply, and the water is now supplied to the office from the Electric Spring, concerning which you were advised in a communication dated Aug. 5, 1909, as follows: —

> The Electric Spring, controlled by the Deep Glen Rock Spring Company, so called, is located near the junction of Greenwood Avenue and Linwood Street in the northwesterly part of Lynn. The examinations of its waters which have been made from time to time show no material change in its quality, and in its present state the water of this spring is probably safe for drinking.

The tubular wells, from which the water supplied to the operatives in the factory is drawn, are situated in the basement of the building, which is located in a densely populated region with sources of pollution at no great distance, and the analyses show that the water has at some time been badly polluted and not subsequently well purified in its passage through the ground before entering the wells. The water is also excessively hard, and in the condition in which it was being supplied to the consumers in the factory at the time this examination was made the water cannot be regarded as safe for drinking, and its use should be discontinued.

MEDWAY.

JAN. 6, 1910.

To the Board of Selectmen of the Town of Medway.

GENTLEMEN: — The State Board of Health has caused a careful examination to be made recently of many of the wells used as sources of water supply by the inhabitants of the villages of Medway and West Medway, to determine the condition of the drinking water supplies in use in those villages, and has caused samples of water from many of the wells to be analyzed.

The wells examined were distributed quite evenly throughout the two villages, ten being located in Medway and nine in West Medway, and most of them are used by several families.

The results of the examination show that the waters of all of the wells examined are badly polluted and unsafe for drinking. Large numbers of bacteria were present in all of the samples, and the water in many cases resembles a partly purified sewage. The pollution of the wells is evidently caused by sewage from neighboring vaults, drains and cesspools, which is not thoroughly purified in its passage through the ground before entering the wells.

In the opinion of the Board, the proper protection of the public health requires that an adequate supply of good drinking water be provided in the villages of Medway and West Medway without further delay.

Nov. 7, 1910.

To the Board of Water Commissioners of the Town of Medway.

GENTLEMEN: — The State Board of Health has considered your application for its approval of the taking of a water supply for the town of Medway from the ground between Populatic Street and the Charles River, about half a mile southeast of the village of Medway, and has caused the locality to be examined by its engineer and has examined the information presented as to the tests made with a view to obtaining a water supply in this region, especially the results of a pumping test made by pumping from a group of wells in this locality for a period of several days ending with Nov. 5, 1910.

From the information furnished to the Board it appears that the wells penetrated a porous soil from which water could be pumped very freely and that during the pumping test the pumps were operated at a rate of about 500,000 gallons per day for several days, the pumping being practically continuous at this rate from October 30 to November 5. Observations upon the level of the ground water in the region about the wells during the test showed that its height was well maintained while pumping at the rate indicated, which is much greater than is likely to be necessary for the supply of the town. The indications furnished by these tests are very favorable for obtaining an ample quantity of water from the ground in this locality for the requirements of Medway.

The results of analyses of samples of water collected at frequent intervals during the test show that it is of satisfactory quality for domestic purposes.

The Board hereby approves the taking of water for the supply of the town of Medway from the ground between Populatic Street and the river in the location at which the recent test was made, under the provisions of chapter 291 of the Acts of the year 1908.

The area of land which it is proposed to acquire about the wells, as shown on the plan presented, will be sufficient for present needs. It may be found desirable to acquire additional areas to prevent the cultivation of the soil or the possible pollution of the ground water from other causes, but additional lands can be acquired at any time in the future if found necessary. The distributing reservoir or standpipe, which, it is understood, will be used in connection with the wells, should be covered so that the water may be kept from exposure to light from the time it is drawn from the ground until its delivery to consumers.

MIDDLEBOROUGH.

JAN. 31, 1910.

To Messrs. ARTHUR H. LEONARD, GRANVILLE E. TILLSON and LOUIS H. CARR,
Middleborough, Mass.

GENTLEMEN: — In response to your request for advice as to what action it is desirable for the town of Middleborough to take to secure a supply of pure water, the Board has caused the well in the valley of the Nemasket River above the town from which the water supply is drawn to be examined and has considered the results of numerous analyses of the water covering a long period of years.

These results show that the water of the well was, when first examined in 1887, of excellent quality for the purposes of a public water supply. It was clear, colorless and odorless and contained but little organic matter, and the quantity of iron present was insignificant. But little change occurred in the quality of the water for several years, but subsequently it began to deteriorate and at the present time it is characterized by the presence of a considerable amount of organic matter and an excessive quantity of iron, which make it very objectionable for domestic uses.

The deterioration in the quality of the water has been due, probably, to the imperfect filtration of water passing through the ground from the Nemasket River, careful observations of the temperature of the water in the well and in the river beside it having shown that a large part of the yield of the well is derived from the latter source.

The conditions which affect unfavorably the character of the water of this well are such that there is no practicable method of improving the quality of the water if its use is to be continued, except by filtering it before it is supplied to consumers. There is probably no doubt that the water can be efficiently purified by aeration and filtration through suitable filters properly operated and a water of good quality obtained, which would be satisfactory for drinking and all domestic purposes. The cost of a proper filtration system, including the necessary filters, pumps and reservoirs, and the cost of maintenance, would very likely, however, be greater than the cost of obtaining a supply of water from a new source if a source can be found which will furnish water of good quality.

The conditions in the region south of the well, and in the valley of the Nemasket River above it, appear to be favorable for obtaining water from the ground in sufficient quantity for the supply of the town of Middleborough, and it is probable that a supply of water of good quality sufficient for all the requirements of the town can be obtained from wells at some place in this region at less expense than the cost of purifying the present water supply and improving it to such an extent that it will be satisfactory for domestic purposes.

In the opinion of the Board, the best course for the town to adopt under the circumstances is to make investigations without delay to determine the practicability and cost of obtaining an adequate supply of good water from some suitable source.

In making these investigations it is advisable to determine first the practicability of obtaining a ground water supply in the neighborhood of the present pumping station, and if this is not found practicable, the investigations should be extended up the valley of the Nemasket River and, if necessary or desirable, in the valleys of tributary streams. It is very important that these tests be made under the direction of an engineer of experience in the selection and development of ground water supplies. The Board is prepared to assist the town in the necessary investigations for securing a satisfactory water supply by making the necessary analyses of water and will, upon request, advise the town as to any proposed source of supply that it may have under consideration or as to the results of any investigations for improving its water supply that the authorities of the town may wish to present.

NEWTON.

SEPT. 1, 1910.

To Mr. J. C. WHITNEY, *Water Commissioner of the City of Newton.*

DEAR SIR: — The State Board of Health received from you on Aug. 8, 1910, the following application relative to a proposed plan of increasing the water supply of the city of Newton: —

> In accordance with chapter 75, section 117, of the laws of the Commonwealth, approval of the Board is asked of a plan for increasing the water supply of the city of Newton by an open well 20 feet in diameter located up-stream 2,200 feet beyond the end of existing conduit and 600 feet from Charles River. In the bottom of this well, grade 78, galvanized pipes 2½ inches in diameter are to be driven through the stratum of sharp sand existing at that point into the layer of coarse gravel underlying the sand.
>
> It is proposed to line this well with cement concrete, dome roof of same and walls carried to sufficient height to exclude floods. In this building to install a submerged pump, water discharging through a 24-inch vitrified pipe with cemented joints into the end of the conduit completed in November, 1909.
>
> Blow-off gates are to be provided and provision made at the large well for possible future extensions into territory still further up river.
>
> It is proposed to provide power by a water motor and generator located at our present pumping station, current being wired to point needed, the water used for power flowing back into the supply. . . .

You have also submitted a general plan, showing the existing works for obtaining water for the supply of the city of Newton and the location of the proposed well, and information has also been presented as to the character of the soil and the results of a pumping test made by pumping from a test well with tubular wells in its bottom at the location of the large well now proposed. In the course of these investigations, it appears from the information presented, water was pumped continuously from the test well from Nov. 24 to Dec. 19, 1909, at an average rate of a little over 500,000 gallons in twenty-four hours, the water being discharged into the river. Samples of water collected from the well on December 2, while the test was in progress, were sent to the laboratory of the Board for analysis.

The plan presented is in effect a modification of the plan of enlarging the water supply of the city of Newton presented for the consideration of the Board in 1908. By the plan presented at that time it was proposed to extend a conduit with its bottom at grade 81 up the valley of the river from the terminus of the present main conduit near Kendrick Street approximately to the location of the well now proposed, a distance of about 3,600 feet. It appears that the construction of that conduit has been begun, but that the work has been completed only to a point about 1,400 feet south of Kendrick Street; and it is now proposed, instead of continuing the construction of the conduit, to install the proposed well and lay a line of pipe to discharge the water into the upper end of the portion of the conduit thus far completed.

The Board has caused the locality to be examined by its engineer and has considered the plan presented and the results of analyses of the samples of water sent in by you during the pumping test in December last. These analyses show that the water of this test well is of about the same character as that of other test wells in this region examined in 1908, and is of good quality for domestic purposes. The quantity of water obtainable from the proposed well, constructed as outlined in the plan presented, with its bottom at grade 78 and with tubular wells sunk to the gravel beneath, would probably amount to approximately the quantity drawn from the well during the pumping test in November and December, 1909, though in very dry seasons, with continued pumping, the quantity obtainable is likely to be less. It is important to provide an additional water supply for the city as soon as practicable, and, considering the circumstances, the Board is of the opinion that the plan is a reasonable one for obtaining an additional supply of good water to meet the immediate needs of the city.

Recent investigations, taken in connection with those of former years, indicate that in the region south of Kendrick Street and west of the river, in which the city of Newton already controls large areas of land, the conditions are very favorable for obtaining a large supply of ground water of good quality, with properly designed collecting works. While by the plan now proposed it will be practicable to obtain a very considerable additional supply of water with little delay and at no very great expense, it is probable that the ground water of this region can be collected best by means of systems or groups of tubular wells driven not only in the upland along the river near the well now proposed, but also near the foot of the gravel slopes which border the low lands in this region, both north and south of the proposed well, and with suitably designed works there is no reason to doubt that a large additional supply of water of good quality can be obtained. In view of these conditions and the probable requirements of the city, the Board recommends that in constructing the works now proposed for drawing water from the well on the former Perry estate and delivering it into the present system, provision be made, so far as practicable, for extending the works whenever necessary in the future, in order to supply from this region a much larger quantity of water than is likely to be obtained from the proposed new well.

NORTHFIELD.

To the Northfield Water Company, Northfield, Mass. MARCH 3, 1910.

GENTLEMEN: — The attention of the State Board of Health having been called to the possible danger to the purity of the water supply used by the Northfield Water Company by the establishment of a lumber camp within the watershed of Minot Brook above your reservoir, the Board has caused the locality to be examined by one of its engineers. The results of the examination show that a number of buildings have been constructed in the immediate neighborhood of the brook, and that no adequate provision has been made for disposing of the sewage, manure and other wastes from the buildings and stables in such a way as to prevent danger of pollution of the brook or its tributaries.

The Board recommends that while the camp is in use, and until all refuse and polluting matter have been removed from the watershed, the consumers of the water be notified to boil it before using. The Board further recommends that you secure the adoption of rules and regulations for the sanitary protection of this watershed under the provisions of section 113 of chapter 75 of the Revised Laws, and thereafter enforce rigidly such rules at all points within the watershed above your reservoir.

It is very desirable, in the opinion of the Board, that the company secure control, if practicable, of the lands within the watershed, especially of those upon the steep slopes leading to the brook or its tributaries above the reservoir; and, if the company does not possess the authority to acquire such lands, it is desirable that such authority be secured as soon as practicable.

NORTON (WELLS).

To the Board of Health of the Town of Norton. JUNE 2, 1910.

GENTLEMEN: — At the request of the superintendent of schools the State Board of Health has caused the wells used as sources of water supply at the high school and at the Sturdy and Barrowsville grammar schools to be examined and samples of their waters to be analyzed.

The results of the analyses show that the water of the well at the high school has at some time been considerably polluted, but subsequently quite thoroughly purified in its passage through the ground before entering the well. There are a number of sources of pollution in the neighborhood of the well, and, while in its present condition the water is probably safe for drinking, it is not a desirable source of water supply, and its quality may deteriorate at any time. The Board recommends that the water of this well be examined from time to time and its use prevented if deterioration occurs.

It is understood that a public water supply is soon to be introduced in the town, and as soon as such a supply becomes available, it will probably be best to use it and discontinue the use of the well water.

The water of the well at the Sturdy Grammar School appears to be of good quality and safe for drinking, and there appear to be no sources of pollution in its immediate neighborhood.

The water of the well at the Barrowsville Grammar School contained a large quantity of organic matter and had an unpleasant odor at the time of the examination. The water is also excessively hard, and, while it does not appear to be exposed to serious danger of sewage pollution, the water in its present state is not suitable for drinking. The well is a new one and it is possible that the quality of the water will improve, if a considerable quantity of water should be drawn from the well, and if, after this is done, the water appears to become better and the odor disappears, the Board will make a further examination, if you so request.

In all cases it appears that the water supplied in the schools is not supplied direct from faucets but through pails or tanks, and there is much danger of contamination of the water if these are not kept clean.

PALMER.

OCT. 8, 1910.

To the Board of Health of the Town of Palmer.

GENTLEMEN: — In response to your request for an examination of the water supplied by the Palmer Water Company and advice as to its condition and the best means of meeting the present emergency, the Board has caused the locality to be examined by its engineer and has examined the information presented as to the existing conditions and the available sources from which water may be obtained.

It is obvious that the present supply is practically exhausted and unless rain comes at once the pressure in the village is likely to drop at any time. The water in the main reservoir is very low and the mud is being stirred up constantly by the fish, so that its condition is very objectionable for domestic purposes. The water of the lower reservoir is rendered turbid by the water of the upper reservoir.

An examination of the region does not show any pond or stream from which an adequate supply of good water can be obtained to meet the present needs without considerable delay. The most favorable of the surface water sources in the neighborhood, from which an additional supply might be obtained with the least delay, is probably Keith's Brook, so called, a stream flowing into the Quaboag River from the north about half a mile west of Blanchardville. If a pump should be set up at this stream and a pipe laid over the surface of the ground to connect with the pipe of the Palmer Water Company in the State road, a distance of from half to three-quarters of a mile, enough water of good quality could probably be obtained to meet the present emergency.

A general examination of the locality indicates that the best and quickest method of obtaining an additional supply is likely to be by sinking tubular wells in the neighborhood of one of the main pipe lines, and an examination of the town indicates that the most favorable place, judging from surface indications, in which to obtain ground water, is north of the State road and northwest of the small pond near Tenneyville. In this locality the soil appears to be coarse and porous and the indications appear to be favorable for obtaining an adequate supply of water from a few tubular wells with little delay.

Another place in which water might be quickly obtained from wells is in the neighborhood of the Quaboag River, south of Tenneyville, near the point where the highway to Monson crosses the river. The Board is informed that one of the pipe-lines of the Palmer Water Company approaches quite near the river at this point and if well water should be obtained here it could be pumped into the main through a few hundred feet of pipe, which could be laid on the surface of the ground.

The Board recommends that measures be taken at once to secure an additional supply of water so as to avoid, if possible, the necessity of introducing polluted water into the supply pipes of the town.

The Board further recommends, after an examination of the existing conditions, that the inhabitants of the town be advised to boil, for the present, all water which is to be used for drinking.

OCT. 8, 1910.

To the Palmer Water Company, Palmer, Mass.

GENTLEMEN: — An examination of the reservoirs of the Palmer Water Company, made on Oct. 6, 1910, shows that the upper one is empty and the lower one very nearly so, and that unless heavy rains occur within the next few days the pressure in the village will fall. The Board has already advised you at previous times that the quantity of water which your present sources of supply are capable of yielding in a dry season is inadequate for the requirements of the village, and has recommended that an additional supply be provided; but except for the raising of the water of the main reservoir, increasing somewhat the storage capacity, no further action appears to have been taken toward providing an adequate quantity of water for the requirements of the town.

After an examination of the locality the Board finds that the best plan of meeting the present emergency will probably be either to take water from Keith's Brook, so called, east of the town, or from tubular wells, favorable locations for which are likely to be found on the northerly side of the State road, northwest of the pond at Tenneyville, or in the valley of the Quaboag River near the road leading from Palmer to North Monson. It is likely that a supply of water can be obtained more quickly and at less expense from wells near the State highway northwest of the pond at Tenneyville than from either of the other sources. The Board recommends that wells be driven here as soon as possible and if water can be obtained from the ground in sufficient quantity, pumping machinery should be set up and the water pumped into the main in the State highway, or, if preferable, into the main leading down from your reservoir to the village. If this work is begun at once, it is possible that it will be completed in time to prevent the necessity of taking into the pipes water from some objectionable source in order to protect the town from fire.

Nov. 3, 1910.

To the Board of Health of the Town of Palmer.

GENTLEMEN: — The State Board of Health has caused an examination to be made of the watershed of Burleigh Brook, from which an auxiliary supply of water is now being drawn for domestic purposes in Palmer, and has caused a sample of the water to be analyzed.

The results show that the water is soft and naturally of good quality for domestic purposes. The watershed of the brook is exposed to danger of pollution from dwelling houses and other buildings, and until adequate provision has been made for preventing danger of pollution of this stream it is important that your recommendation that the water be boiled before using be strictly followed.

Of the sources of pollution on the watershed the most important are the buildings in the immediate neighborhood of the point from which the water is now being taken. It is important that the surface water which may flow from the neighborhood of these buildings and the surface water from the street above the intake be diverted to the stream below the temporary dam. Farther up-stream, east of the highway and about 150 feet south of the brook, is a small building said to be occupied by one person, drainage from which may enter the stream, and the possibility of pollution of the stream from this source should be prevented. A short distance farther up the valley is a portable saw-mill and a large pile of sawdust, so located that portions of it are likely to be washed into the brook in time of rain. It is very important that provision be made for keeping this material out of the brook. Should the saw-mill again be operated while the water of the brook is still being used, it will be very important that provision be made for preventing the pollution of the brook by sewage or other objectionable wastes from this place. Farther up-stream, in the neighborhood of the point where the highway from Palmer to Palmer Center crosses the brook, there are a number of buildings so located that polluting wastes from some of them may find their way into the stream. These grounds should be carefully examined and pollution of the brook by objectionable wastes from these buildings prevented. There are several other buildings within the watershed, all of which should be carefully examined and such measures taken as may be necessary to prevent the pollution of the stream, so far as possible, while its use as a temporary source of water supply shall continue.

The Board again urges the great importance of action on the part of the Palmer Water Company or of the town to secure an adequate quantity of good water sufficient for the requirements of the town at all times.

PALMER (SPRINGS IN THREE RIVERS).

MAY 5, 1910.

To the Board of Health of the Town of Palmer, Mr. S. O. MILLER, *Clerk.*

GENTLEMEN: — In response to your request for an examination of the water of the Cheney Springs, so called, situated in the village of Three Rivers, which are used to supply several dwelling houses, the Board has caused the springs and their surroundings to be examined and a sample of the water to be analyzed.

It appears that the springs are located on the slope of a hill at a considerable elevation above the river, and that the slopes above them are uninhabited. The analysis shows that the water is of good quality, and, in the opinion of the Board, the source is a desirable one from which to take water for drinking. It is understood that the storage basin now in process of construction is to be covered and protected from the entrance of surface water.

The Board has also caused an examination to be made of the water of a spring and tubular well near Thorndike, and has advised the Thorndike Manufacturing Company as to the character of the water of these sources. A copy of this advice is enclosed herewith.

PALMER (THORNDIKE).

MAY 5, 1910.

To the Thorndike Manufacturing Company, Palmer, Mass.

GENTLEMEN: — In response to a request from the board of health of the town of Palmer, the State Board of Health has caused an examination to be made of the water of a spring and tubular well which, the Board is informed, are being considered as sources of water supply for your factory and tenement houses in Thorndike.

The results of the analyses show that the water of both sources is of good quality for drinking, though the water of the well contained when examined a rather larger quantity of iron than is found in good well waters, but this objection may disappear after a considerable quantity of water is pumped from the well. It is understood that this well was sunk to a considerable depth in rock and that other wells are now being driven. It is rarely practicable in this State to obtain water in any considerable quantity from wells sunk in rock, and the Board advises that in the further tests the investigations be directed to securing water at some point where there is a considerable depth of coarse and porous soil, which will yield a sufficient quantity of water for your requirements. It is desirable that the further investigations be made under the direction of an engineer of experience in matters relating to ground water supplies, and the Board will assist you, if you so request, in the further investigations by making the necessary analyses of water and will give you further advice in the matter when the results of the further tests are available.

PEABODY. FEB. 3, 1910.

To the Board of Selectmen of the Town of Peabody, Mr. A. N. JACOBS, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on Dec. 24, 1909, a petition for its consent to and approval of the taking by purchase or otherwise of certain lands within the watershed of the Reservoir, so called, in the town of Peabody for the purpose of protecting and preserving the purity of the water of said Reservoir, which is used as a source of water supply for the town, accompanied by a plan and a description of the said lands.

In response to this petition the Board gave a hearing at its office, Room 143, State House, on Thursday, Feb. 3, 1910, after publishing notice of said hearing in the "Lynn Evening News," the "Lynn Evening Item," and the "Salem Evening News." After the hearing, at which no one appeared to oppose the taking of the lands in question by said town, and after an examination of the lands proposed to be taken as described in your petition, the Board, upon consideration, voted to consent to and approve the taking by the town of Peabody of certain lands now or formerly of Eliza E. Manning, Augusta B. Trask, Laura J. Shillaber, George C. Roome and others, located westerly of the Reservoir and within the watershed thereof, amounting to 5.234 acres more or less, shown on the plan presented with your petition entitled "Plan showing Land of Geo. C. Roome et al., sold to Town of Peabody, Scale 1 inch = 100 ft., December 1909, F. A. Barbour, Eng'r."

The lands the taking of which is herein approved are comprised in two parcels, which are bounded, measured and described as follows: —

Beginning at the southeast corner of the premises by land now or formerly of Phillips and land of the Town of Peabody, thence running northeasterly by land of the Town of Peabody five hundred feet and one half to land now or formerly of Robert P. Brown, thence westerly but slightly northerly by said land now or formerly of Brown three hundred eighty seven and two tenths feet to land now or formerly of Laura J. Shillaber, thence southerly but slightly westerly by land now or formerly of Shillaber five hundred and two and six tenths feet to land now or formerly of Phillips, thence southeasterly by said land now or formerly of Phillips three hundred and eighty five feet to land of the Town of Peabody and the point begun at. Together with a right of way from Lynn Street to said parcel above described over land now or formerly of Eliza E. Manning, Augusta B. Trask and Laura J. Shillaber, said right of way having been laid out by Charles A. Sayward, John E. Herrick and Thomas H. Jackman, Commissioners, May 22, 1899, on a petition for partition filed in the Probate Court for Essex County, Massachusetts, said right of way being described as follows, viz.; Beginning on Lynn Street by land now or formerly of Laura J. Shillaber, thence running northeasterly by said Shillaber's land one hundred and forty two feet, thence on the same course seven hundred and nine feet to land now or formerly of Albert C. Roome and others, being the parcel above described, this line being the southeasterly side of said right of way, the northwesterly line being parallel to and forty feet distant therefrom.

PEPPERELL. JAN. 6, 1910.

To the Board of Water Commissioners of the Town of Pepperell.

GENTLEMEN: — The State Board of Health has considered your application for the approval of the taking of water for the town of Pepperell from a group of tubular wells located near Gulf Brook in the northerly part of the town, and has caused the locality to be examined by one of its engineers and samples of the water of the wells to be analyzed.

The results of the analyses show that the water is of good quality for the purposes of a public water supply, and the tests made to determine the quantity of water obtainable from the ground where the wells are located indicate that enough water is likely to be obtained there for all reasonable requirements of the town.

The Board approves the source of water supply and approves the location of the tubular wells from which water is now being taken, the wells being located on the east side of Gulf Brook on land now or formerly of E. E. and A. A. Tarbell, as shown on the plan of the said lands on file in this office, entitled "Pepperell Water Works. Plan of driven wells and connections. Scale 1 inch = 10 feet. July 1909. W. S. Johnson, Civil Engineer, Boston, Mass."

PITTSFIELD.

MAY 24, 1910.

To the Board of Public Works of the City of Pittsfield.

GENTLEMEN: — The State Board of Health received from you on April 5, 1910, the following petition relative to taking the waters of certain tributaries of Roaring Brook in the town of Washington and certain land in said town, for the purpose of increasing the water supply of the city of Pittsfield: —

To the State Board of Health.

Respectfully represents the board of public works of the city of Pittsfield that for the purpose of increasing the water supply of said city it proposes to take the waters of certain tributaries of Roaring Brook in the town of Washington in said county and certain land in said town necessary for such purpose as more fully appears by a plan filed by the engineer of said board of public works, said taking to be under the provisions of chapter 514 of the Acts of 1907; and the said board of public works hereby respectfully petitions your Honorable Board to approve the taking of said land and the acquiring thereof after a hearing duly appointed and held by your Honorable Board under the provisions of said act; and that your Honorable Board further approve the plans for taking, storing, conveying, and diverting said water of said brooks, and the plan for the construction of all work necessary therefor.

BOARD OF PUBLIC WORKS OF THE CITY OF PITTSFIELD,
By M. B. WARNER,
City Solicitor.

The petition was accompanied by two plans: one, entitled "General Plan, Roaring Brook-Mill Brook Development. January, 1910," signed by the board of public works, showing the location of a proposed storage reservoir, which is to have a capacity of 275,000,000 gallons, on the southerly arm of Mill Brook, and the location of a proposed pipe line, conduit and channel leading up from the reservoir on Mill Brook through the valley of said brook and across the divide into the watershed of Roaring Brook to tributary No. 4 on said brook; the other plan is entitled "City of Pittsfield. Land situated on Watershed of Projected Mill Brook Storage Reservoir. April, 1910," showing outlines of lands in the valleys of Mill Brook and Roaring Brook which it is proposed to acquire in connection with the plan of increasing the water supply of said city.

By the provisions of said chapter 514 of the Acts of the year 1907, it is provided that "no lands shall be taken or otherwise acquired under the authority of this act except with the approval of the state board of health after a hearing, and that all works for taking, storing, conveying or diverting water shall be constructed in general accordance with plans approved by said board." Excepting the very general plans showing the outlines of the scheme described above, the plans of the works for taking, storing, conveying or diverting the water have not yet been received by the Board, and the Board is unable to take definite action upon the matter at the present time.

The land which you propose to take is a wilderness, and the water derived therefrom is unpolluted and likely to remain unpolluted at least for many years. The water of Mill Brook is of good quality for water supply purposes. The water of the main stream of Roaring Brook is objectionable on account of the high color and large quantity of organic matter usually present, but the water of the tributaries of Roaring Brook is of better quality, and it is probable that by excluding the water of Clapp Pond and of the swamp lands along the pond and the brook, if it is found practicable to do this, and making some improvements in the watersheds of some of the tributaries, good water can be obtained from this watershed.

It appears from the information furnished at the hearing that other sources of supply are available and may be more appropriate than the plan of development thus far outlined to the Board, but that the careful study required to determine the most appropriate and desirable source of supply has not been completed. As soon as these investigations have been completed, and the plans showing all the works for taking, storing, conveying and diverting the water are submitted, the Board will give the matter prompt consideration.

JUNE 2, 1910.

To the Board of Public Works of the City of Pittsfield.

GENTLEMEN: — The State Board of Health received from you on May 31, 1910, an application requesting the approval by the Board of the taking of water from Onota Lake as a temporary water supply for the city of Pittsfield under the provisions of chapter 25, section 35, of the Revised Laws, the water to be taken at the same point (near the southerly end of the lake) and under the same conditions as were approved last year.

The Board is informed that Ashley Lake is still several feet below high water, and it is evident that unless the rainfall of the coming months shall be larger than usual there is likely to be a shortage of water in the city before the end of the year. In the opinion of the Board, it is very desirable that an auxiliary supply should be provided without delay, and the Board approves the taking of the waters of Onota Lake as a temporary source of water supply for the city of Pittsfield under the provisions of chapter 25, section 35, of the Revised Laws. It is of course important, as recommended last year, that the watershed of the lake be carefully inspected while in use and danger of contamination of the water prevented.

JULY 21, 1910.

To the Board of Public Works of the City of Pittsfield.

GENTLEMEN: — The State Board of Health received from you on April 5, 1910, the following petition under the provisions of chapter 514 of the Acts of the year 1907: —

> Respectfully represents the board of public works of the city of Pittsfield that for the purpose of increasing the water supply of said city it proposes to take the waters of certain tributaries of Roaring Brook in the town of Washington in said county and certain land in said town necessary for such purpose as more fully appears by a plan filed by the engineer of said board of public works, said taking to be under the provisions of chapter 514 of the Acts of 1907; and the said board of public works hereby respectfully petitions your Honorable Board to approve the taking of said land and the acquiring thereof after a hearing duly appointed and held by your Honorable Board under the provisions of said act; and that your Honorable Board further approve the plans for taking, storing, conveying, and diverting said water of said brooks, and the plan for the construction of all work necessary therefor.

The petition is accompanied by a communication of the committee on water supply, a general plan showing the outlines of a scheme for increasing the water supply of the city by constructing a storage reservoir on the south branch of Mill Brook and diverting into it the waters of the upper part of the Mill Brook watershed and of tributaries Nos. 4 and 5, so called, of Roaring Brook, and by a plan and description of the lands which it is proposed to acquire in the watershed of Mill and Roaring brooks. Subsequently, on July 7, further plans were submitted with a report of your consulting engineer on the practicability and probable cost of the proposed works, and finally a further report as to the feasibility and cost of diverting the water of tributaries Nos. 1, 2 and 3 of Roaring Brook into the proposed Mill Brook reservoir.

The plan as finally presented provides for constructing a storage reservoir, having a capacity of about 275,000,000 gallons, on the south branch of Mill Brook near the Dellea place, and for diverting into this reservoir, by means of dams, conduits or pipe lines, the waters of the upper part of the watershed of Mill Brook and the waters of the five principal tributaries of Roaring Brook and Clapp Pond. The plan also includes an additional pipe line from the reservoir to the city of sufficient capacity to make it practicable, in connection with the present pipe line, to draw the entire supply of the city if necessary from the proposed new reservoir.

The Board has examined the plans presented and has considered the information available as to the character of the watersheds and the quality of the water of the streams from which the supply is to be taken, and has given a hearing upon the question of the taking of the lands which it is proposed to acquire in connection with the plan under the provisions of chapter 514 of the Acts of the year 1907.

The watersheds of the various streams tributary to Mill Brook and Roaring Brook, which are to be utilized under the proposed plan, are uninhabited, and the waters of these streams, judging from the limited number of analyses available, are considerably softer than the waters of the sources now in use. The waters of the tributaries of Mill Brook and of most of the tributaries of Roaring Brook have little color, some of them being practically colorless. One of the tributaries, however, known as tributary No. 2, or Sand Wash Brook, is affected by a very considerable color, evidently due to the contact of this water with vegetable matter in the swamps through which the stream flows. While the water of this stream, after mingling with the other waters which are to be tributary to the proposed new reservoir, would probably not affect very seriously the color of the water supplied to the city, it appears to be practicable, at no great expense, to drain the swamps through which the stream flows, and thus reduce the color materially. In the opinion of the Board, if the proposed reservoir is thoroughly prepared for the storage of water by the removal of the soil and organic matter from the area to be flowed, as planned, and if the watershed of the tributaries is improved as necessary by ditching the swamps, the proposed new works will supply water of good quality for all the purposes of a public water supply.

The increase in the quantity of water that will be secured by the adoption of the plan now proposed is somewhat limited and will depend to a considerable extent upon the care used in operating the works and in the construction and maintenance of the diversion conduits, dams and pipe lines. With proper construction and good management the new works will probably increase the supply of water available to the city from 80 to 90 per cent. over the capacity of present sources in dry years; that is, the available supply will be increased from about 2,550,000 gallons per day to 4,500,000 gallons, or possibly somewhat more. The quantity of water now used, however, is considerably in excess of the capacity of the present works, and the increase over the quantity of water now used will be only from 60 to 70 per cent.

It is impossible to determine, in the absence of a thorough investigation as to the various sources of supply available, whether or not the plan now proposed is the most economical one for the city to adopt, but the proposed works appear to the Board a reasonable development of the sources of gravity supply in the mountains southeast of the city, and under the circumstances the plan appears to the Board a reasonable method of securing an additional water supply for the city. The Board approves the location of the proposed reservoir and the general plan of diverting into this reservoir the waters of the upper part of the main stream of Mill Brook and the waters of the tributaries of Roaring Brook designated as Nos. 1, 2, 3, 4 and 5, the details of which have not yet been presented. These works must be designed with care in order to secure the best results, and in addition provision should be made for swamp drainage in the watershed of tributary No. 2 and for clearing the channels of the other streams when necessary. The Board also approves the taking of land for the construction and development of the proposed works, as shown upon a plan filed in the office of the Board on May 5, 1910, and entitled "City of Pittsfield. Land Situated on the Watershed of Projected Mill Brook Storage Reservoir. Scale 300 ft. = 1 in. April, 1910. Lindholm & Tuller, Eng'rs." The description of the lands, the taking of which is hereby approved, is appended hereto.

In the construction of the works now proposed it will be necessary to introduce into the watershed of Mill Brook above the dam from which the water is taken for the supply of the city a large number of laborers, and it will be essential that great caution be exercised to prevent danger of the pollution of the water. If practicable the use of this water should be avoided while the work is in progress. It will also be essential to prevent danger of the pollution of the watersheds of the Roaring Brook valley, from which water is to be taken under the proposed plan.

The quantity of water supplied to the city of Pittsfield during the year 1909 amounted, according to the records of your board, to an average of 2,808,000 gallons per day. While the census of 1910 is not yet available and a definite estimate of the population is impracticable, it is probable that the quantity of water used in 1909 amounted to more than 90 gallons per inhabitant per day. This quantity of water is greatly in excess of the amount used per person in cities and towns where the water supplied to consumers is metered and the necessary care taken in the maintenance of the works to prevent excessive loss of water by leakage from mains and distributing pipes and waste from other causes. If the measures found successful in other places in restricting the unnecessary use and waste of water should be applied in Pittsfield, there is no reason to doubt that the excessive use of water could be prevented, and the necessity for further large expenditures in securing an additional water supply for the city, which is likely otherwise to become necessary soon after the completion of the works now planned, might be postponed for several years. The Board recommends that effective measures for reducing the unnecessary consumption and waste of water be instituted without delay.

The Board also recommends that the investigations for an additional water supply which have led to the recommendation of the present plans be continued, and a thorough study made to determine the most appropriate source or sources for the future water supply of the city, since, if the present rate of growth continues, even with a reduction in the use of water, a further additional supply will be required before many years. This work should be carried out with thoroughness and the future policy of the city in the matter of water supply determined so far as practicable, so that when further additions to the works are required they may be undertaken in ample season.

DESCRIPTION OF LANDS TO BE TAKEN FOR PITTSFIELD WATER SUPPLY.

William C. Whitney Estate.

Beginning at a stone monument marked P. W. W. standing in the south-east corner of land of one Congdon and the south-west corner of land formerly of one Keating, and now owned by the City of Pittsfield; thence running in a course North sixty-six degrees and thirty minutes West (N. 66° 30′ W.) along land of one Congdon, a distance of nine hundred seventy-seven and eight tenths (977.8) feet to a point on or near the east line of an old road leading to the house of one Congdon, now deceased; thence in a course South twenty-four degrees thirty minutes West (S. 24° 30′ W.) along land of the City of Pittsfield, a distance of fourteen hundred fifty (1450) feet to a stone monument marked P. W. W.; thence in a course North sixty-five degrees thirty minutes West (N. 65° 30′ W.) a distance of two hundred thirty-nine (239) feet to a stone monument marked P. W. W.; thence in a course South twenty-four degrees thirty minutes West (S. 24° 30′ W.), a distance of nineteen hundred eighty (1980) feet to a stone monument marked P. W. W.; thence in a course North sixty-five degrees thirty minutes West (N. 65° 30′ W.) a distance of eight hundred fifty-five (855) feet to a point; the last stated courses are along land of the City of Pittsfield; thence in a course South twenty-three degrees West (S. 23° W.) along land of Caroline Dewey, a distance of five hundred fifty-one (551) feet to a point at the north-west corner of land now or formerly of Oliver S. Hutchinson; thence in a course South sixty-six degrees forty-eight minutes East (S. 66° 48′ E.) along land of said Hutchinson and land of said Dewey, a distance of sixteen hundred seventeen (1617) feet to a point at the north-east corner of land of Caroline Dewey; thence in a course South twenty-two degrees thirty-five minutes West (S. 22° 35′ W.) along land of said Dewey, a distance of twenty-one hundred (2100) feet, to a cherry tree or stump thereof, at the south-east corner of land of Oliver S. Hutchinson; thence in a course North sixty-seven degrees fifty-three minutes West (N. 67° 53′ W.) along land of Hutchinson, a distance of five hundred (500) feet to a point; thence in a course South twenty-three degrees West (S. 23° W.) and crossing Roaring Brook, a distance of five hundred (500) feet to a point; thence in a course South sixty-seven degrees East (S. 67° E.), a distance of fourteen hundred eighty-four (1484) feet to a point on or near the west line of the highway leading from New Lenox to Washington; thence running southerly along the line of the aforesaid highway a distance of three hundred twenty-three (323) feet to a point; thence running easterly along a private road a distance of one thousand five and eight tenths (1005.8) feet to the center of Roaring Brook; thence running south-easterly up the center of Roaring Brook, a distance of about thirty-four hundred (3400) feet to the westerly line of one Congdon, now deceased; the last mentioned courses are along lands of William C. Whitney Estate; thence in a course North twenty-four degrees thirty minutes East (N. 24° 30′ E.) along land of Congdon a distance of forty-four hundred eighty-five (4485) feet to a point in the south line of land of one Dillon; thence in a course North sixty-six degrees West (N. 66° W.) along land of Dillon, a distance of eight hundred twenty (820) feet to a point at the south-west corner of land of said Dillon; thence in a course North twenty-four degrees East (N. 24° E.) along land of Dillon, a distance of sixteen hundred fifty (1650) feet to the highway leading to Washington, and locally called Monument Hill Road; thence crossing and running easterly along the aforesaid highway, a distance of about fourteen hundred and fifty-one (1451) feet; thence crossing said highway to the southwest corner of land of one Killian; thence in a course North twenty-one degrees thirty minutes East (N. 21° 30′ E.) along land of Killian, a distance of sixteen hundred twenty (1620) feet to the south line of land of the City of Pittsfield; thence north-westerly along land of the City of Pittsfield to the place of beginning. Reference may be had to a plan hereto attached.

Real Estate of Caroline Dewey.

Beginning at a point on or near the highway leading from New Lenox to Washington at the north-westerly corner of the parcel of land about to be conveyed; thence running in a course South sixty-six degrees forty-eight minutes East (S. 66° 48′ E.) along land of the William C. Whitney Estate, a distance of eight hundred sixty-seven (867) feet to a point; thence in a course South twenty-two degrees, thirty-five minutes West (S. 22° 35′ W.) along land of the said Whitney Estate, a distance of two thousand forty-six (2046) feet to the line of the above mentioned highway; thence Northwesterly and Northerly along the above stated highway to the place of beginning, containing thirty-six (36) acres. Reference may be had to a plan attached hereto.

Real Estate of Oliver S. Hutchinson.

Beginning at a cherry tree or stump thereof, standing in the South-east corner of the parcel of land about to be conveyed, thence running in a course North sixty-seven degrees and fifty-three minutes West (N. 67° 53′ W.) along land of the William C. Whitney Estate, a distance of sixteen hundred and seventeen (1617) feet to a point; thence in a course North twenty-three degrees and seven minutes East (N. 23° 07′ E.) along land of Caroline Dewey a distance of two thousand one hundred and thirty (2130) feet to a point; thence in a course South sixty-six degrees and forty-eight minutes East (S. 66° 48′ E.) along land of the said Whitney Estate to the line of the highway leading from New Lenox to Washington; thence running southerly and easterly along the line of the said highway to a point; thence running in a course South twenty-two degrees thirty-five minutes West (S. 22° 35′ W.) a distance of fifty-four (54) feet to the place of beginning. The above described lot is a parcel of land conveyed to the grantor by Jane Dexter and contains forty-two and eight tenths (42$\frac{8}{10}$) acres of land. Reference may be had to a plan attached hereto.

Nov. 28, 1910.

To the Board of Public Works of the City of Pittsfield.

GENTLEMEN: — The State Board of Health received from you on Oct. 15, 1910, a petition requesting the approval by the Board of the taking and diversion of the water of certain tributaries of Roaring Brook and the taking of certain lands in the watershed of said brook in the town of Washington, under the provisions of chapter 514 of the Acts of the year 1907, said lands being shown upon a plan submitted with your application, entitled "Roaring Brook-Mill Brook Development. Plan of Land, Washington, Mass. Scale: 400 ft. per inch. September 1910. City of Pittsfield. A. B. Farnham, Engineer, Board of Public Works." You have also submitted a plan and profile of a proposed conduit extending from the proposed new reservoir on the south arm of Mill Brook into the watershed of Roaring Brook and along the northerly side thereof to the neighborhood of Mud Pond; the plan and profile, together with cross-sections of the proposed conduit and channel, being shown upon a plan entitled "Roaring Brook-Mill Brook Development. Plan & Profile of Proposed Conduit, Washington, Mass. Scale: 400 ft. per inch, October 1910. City of Pittsfield. A. B. Farnham, Engineer, Board of Public Works." This plan was filed with the State Board of Health on Oct. 26, 1910, and subsequently further information was submitted showing the elevation of Roaring Brook at various points, and the elevation of Clapp Pond and Mud Pond.

The State Board of Health, in accordance with the provisions of chapter 514, above referred to, gave a hearing at its office on November 3, with reference to the taking of the lands proposed in your petition, notice of the hearing having been published in newspapers in the city of Pittsfield. After the hearing, at which no one appeared to oppose the purchase or taking of the lands in question, the Board voted to approve the taking by the city of Pittsfield of the lands in the valley of Roaring Brook, as shown upon the plan submitted with the petition. A description of the lands, the taking of which is hereby approved, is appended hereto.

The Board has also considered the plans of the proposed conduit designed to intercept the tributaries of Roaring Brook and divert the waters of these tributaries and of areas draining into Roaring Brook to the proposed Mill Brook reservoir. There are certain modifications of the plans and profile that the Board would recommend. The grade of high-water line in the open conduit and of the manholes of the closed conduit when passing through ground from which water is to be gathered should be below the grade of the ground water in a dry time. The notes that have been received by the Board are not complete upon this point, but they indicate that the grade of the closed conduit from Station 50 to Station 78 should be lower than indicated upon the plans, and the conditions above stated should be established here and elsewhere on the line of the conduit.

The capacity of the conduit the Board would recommend to be capable of conveying 6,500,000 gallons per day per square mile of gathering area.

At its upper end in the neighborhood of Clapp Pond and Mud Pond the conduit as now planned passes through a swamp, and tributary conduits are indicated on the plans to receive the water from the upper tributaries. It is very important to exclude from the conduit the water of the undrained swampy areas in that region, which is highly colored and contains much organic matter. It may be found desirable in constructing the works in this section to locate the conduit farther east at the edge of the swamp, in order that objectionable swamp water may with certainty be excluded. It will also be important to drain the swamps upon the Sand Wash Brook, the water of which is seriously colored at times by vegetable matter.

The success of the plan will depend to a large degree upon the detailed design and proper construction of the works and the efficient maintenance of the conduit and connections.

The details of design, involving engineering questions of stability, adaptation to the ground and details of construction, have not been investigated by the Board, but the general plan of the works for obtaining water from the gathering ground and conveying it to and storing it in the reservoir formed by the dam, as proposed, modified by the suggestions herein contained, is approved by the Board under the provisions of chapter 514 of the Acts of the year 1907.

Description of Lands owned by the William C. Whitney Estate and the Henry Congdon Estate in the town of Washington to be taken for Pittsfield Water Supply.

Beginning at a point on the easterly bank or shore of Roaring Brook where it crosses the south line of a private road of the William C. Whitney estate which place of beginning is about one thousand feet (1,000 ft.) up stream from where Roaring Brook crosses the highway leading from New Lenox to Washington and Becket; thence running up the stream of said Roaring Brook and along the easterly bank thereof to the north line of land formerly of one Henry Congdon; thence north twenty-four degrees and thirty minutes east (N. 24 deg. — 30′ E.) along the line of said land formerly of said Congdon four hundred feet (400 ft.); thence south forty-three degrees east (S. 43 deg. E.) two thousand feet (2,000 ft.); thence north forty-seven degrees east (N. 47 deg. E.) one thousand nine hundred feet (1900 ft.); thence southeasterly about three thousand two hundred feet (3200 ft.) to a point in the north line of the Sand Hill Road so called, two hundred and twenty-five feet (225 ft.) easterly of the centre line of Sand Wash Brook so called; thence southwesterly on the north line of said Sand Hill Road about four thousand eight hundred seventy-nine feet (4,879 ft.) to a point which is five hundred fifty feet (550 ft.) easterly of the centre of the intersection of the private macadam road of the Whitney estate and said Sand Hill Road; thence northwesterly a distance of about four thousand three hundred feet (4300 ft.) in a straight line passing westerly of the extreme west shore of Mud Pond so called and distant therefrom one hundred and fifty feet (150 ft.) to an iron pin marked PWW; thence north thirty-two degrees and forty-five minutes west (N. 32 deg. 45′ W.) two thousand and fifty feet (2050 ft.); thence north twenty-three degrees west (N. 23 deg. W.) one thousand nine hundred and fifty feet (1950 ft.); thence north sixty-seven degrees west (N. 67 deg. W.) about two hundred and fifty feet (250 ft.) to the south line of the aforesaid private road of the Whitney estate; thence along the south line of said private road to the place of beginning.

Also one other piece or parcel of land bounded and described as follows:

Beginning at the southerly line of said Sand Hill Road at a point two hundred and twenty-five feet (225 ft.) easterly of the centre of said Sand Wash Brook where it crosses said road; thence south forty-two degrees east (S. 42 deg. E.) one thousand feet (1000 ft.); thence south forty-eight de-

grees west (S. 48 deg. W.) six hundred twenty-five feet (625 ft.); thence north forty-two degrees west (N. 42 deg. W.) about eight hundred forty feet (840 ft.) to the south line of said Sand Hill Road; thence northeasterly along the south line of said road about six hundred and ninety feet (690 ft.) to the place of beginning; said two parcels of land containing about three hundred and seventy-six (376) acres.

PLYMOUTH.

AUG. 4, 1910.

To the Board of Water Commissioners of the Town of Plymouth, Mass.

GENTLEMEN: — In response to a petition filed with this Board on July 22, 1910, and your communication, together with a statement from the local board of health appended thereto, relative to a temporary modification of rule 14 of the rules and regulations adopted by this Board on Feb. 6, 1908, for the sanitary protection of the water supply of the town of Plymouth so as to permit bathing in Boot Pond, the Board has caused the locality to be examined and has considered the information presented with the petition.

An examination of the pond shows that its waters are not now directly connected with any of the other ponds used as sources of water supply by the town of Plymouth and that no means now exist for drawing water for the supply of the town from said pond. It is probable that the water of this pond filters through the ground to Great South Pond, and in very wet weather water flows from Boot Pond to Great South Pond.

Considering the circumstances, the Board hereby modifies its regulation of Feb. 6, 1908, prohibiting bathing in the waters of Boot Pond in Plymouth, by limiting this prohibition to times when the distance between the waters of the two ponds at the nearest point is less than 100 feet.

RANDOLPH AND HOLBROOK.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules 7, 14 and 15 of the rules and regulations adopted by the Board on July 7, 1904, for preventing the pollution and securing the sanitary protection of the water supply of the towns of Randolph and Holbrook, were amended on May 5, 1910.

RUSSELL.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on Oct. 6, 1910, for preventing the pollution and securing the sanitary protection of the waters of Black Brook and its tributaries, used by the town of Russell as a source of water supply.

OCT. 6, 1910.

To Mr. E. D. PARKS, *Chairman, Board of Water Commissioners, Russell, Mass.*

DEAR SIR: — In accordance with your request of Sept. 28, 1910, the State Board of Health has adopted rules and regulations for the sanitary protection of the water of Black Brook which is soon to be used for the supply of the town of Russell.

An examination of the watershed shows that there are several dwelling houses with outbuildings within its limits, most of which are so situated that with proper enforcement of the rules there should be no serious danger of the pollution of the water. There are, however, certain very serious sources of pollution which should be removed before the water is used. Chief among these is a lumber camp, situated at the upper end of the watershed, at which there are no sanitary provisions, and provision must be made for the proper disposal of the sewage and other wastes from this camp if pollution of the water supply is to be avoided. At another camp occupied by wood-choppers, which is situated close to the main stream a short distance above the reservoir, the conditions are extremely unsanitary, and the surroundings of this camp should be thoroughly cleaned and the necessary sanitary precautions enforced, else the stream will inevitably be seriously polluted at this place. It would be much better if this camp should be removed from the watershed.

It also appears that at one of the dwelling houses on the Blandford Road sewage is discharged directly into a tributary of Black Brook. These drains should be removed and the sewage disposed of in accordance with the provisions of the rules.

There are also other sources of pollution which have already been indicated to you by the assistant engineer of this Board, which should receive the necessary attention to prevent danger of pollution of the stream before the water is used.

The water of Black Brook should not be supplied to the town until the pollution of the stream has been prevented, especially the pollutions due to the lumber camps and wood-choppers' cabins, and no water should be used from this source for a period of a month after the pollutions have been removed.

SALEM.

To the Salem Water Board, Mr. HENRY E. REYNOLDS, *Clerk.* JUNE 7, 1910.

GENTLEMEN: — The State Board of Health received from you on May 4, 1910, the following communication requesting its opinion as to the advisability of granting permits for boating and fishing upon Wenham Lake: —

> The Salem water board having under consideration the vexed question of licenses for boating or fishing upon Wenham Lake and being divided in

their opinions, have directed me to ask the State Board of Health the following questions: —

First. — If in their judgment it is proper or advisable to grant licenses to boat or fish upon any pond the water of which has been taken for domestic use.

Second. — Is boating or fishing allowed (within your knowledge) upon any of the great ponds in the State, the waters of which have been taken for domestic use?

Any information you can give us on this question will be greatly appreciated.

The Board has carefully considered the desirability of granting permits for boating and fishing on Wenham Lake and the possible dangers arising therefrom. The granting of unlimited boating and fishing permits on Wenham Lake would, in the opinion of the Board, be a great danger to the health of those who use the water, since it is obviously impracticable to inspect properly a large number of boats in different parts of the lake, and no inspection of any value is possible at night.

In 1906 and 1907, when for a time the regulation of boating and fishing on Wenham Lake was carried out by the Board, the plan adopted after careful consideration of the circumstances was to grant a limited number of permits for boating and fishing under certain conditions and with careful inspection; and it appears to the Board that a similar plan may reasonably be adopted for the present year and its results carefully observed to determine whether it is safe to continue this practice in the future. Its safety will of course depend to a large extent on the conduct of the persons to whom permits are given, and if this conduct and the conditions are such as to warrant the continuation of the practice, it may be continued for a time. If, on the other hand, it is found impracticable to secure proper observation of the necessary sanitary precautions, then boating and fishing must be prohibited if the safety of the health of those using the water of this source of supply is to be properly protected.

The Board advises, then, that a limited number of permits for boating and fishing on Wenham Lake be granted under the following conditions: —

1. There shall be no fishing within the limits of that portion of the lake lying within the city of Beverly.
2. Persons keeping boats on the lake within the limits of the city of Beverly must when using them proceed directly to the portion of the lake within the limits of Wenham, and upon returning must return directly to their boat landings, keeping as far as practicable from the intakes of the water works.

3. Each person to whom a permit is granted should be informed of the necessity of careful observation of the conditions, and the necessity that will exist, in case the conditions are not observed, for removing the privilege altogether.

4. Permits should be granted only to persons owning a boat on the lake and should not be granted to persons who keep boats to let to the public.

Persons granted permits should subscribe to the following further conditions: —

1. Not to use firearms or explosives while upon the waters of the lake.
2. Not to spit, throw any fish, food, animal or vegetable matter or any other matter tending to pollute the water into the water of said lake or leave the same upon its shores.
3. Not to throw any cans, bottles or boxes into the water of said lake or leave the same upon its shores.
4. To comply with all rules and regulations of the State Board of Health relative to the waters or the watershed of said lake.
5. To exhibit the permit, when called upon to do so by any officer of the law or by any agent, officer, member or employee of the State Board of Health or of the water board of the city of Salem or of the city of Beverly.
6. Not to let or allow any other person or persons to use any boat owned by the person to whom the permit is granted unless accompanied by that person.
7. To paint or cause to be painted plainly on the outside of the boat on each side in prominent figures the number of the permit.

The Board is further of the opinion that fishing from the shores of the lake can be permitted at certain specific points where the practice may be subject to inspection.

Finally, the Board recommends a very careful inspection of the lake by your board, to see that all the conditions relative to boating and fishing are carefully observed. It appears from the records of the Board that eighty permits were granted in the year 1907 for boating and fishing on Wenham Lake to citizens of Salem, Beverly and Wenham, and that persons authorized to use a boat upon Wenham Lake were also authorized to allow the use of the boat by members of their families if the names of said members were specified in the permit.

SOUTH HADLEY (SOUTH HADLEY FIRE DISTRICT NO. 2).

APRIL 7, 1910.

To the Committee on Water Supply of Fire District No. 2 in the Town of South Hadley.

GENTLEMEN: — The State Board of Health received from you on March 21, 1910, an application for advice as to a proposed water supply for Fire District No. 2 in the town of South Hadley, accompanied by a plan and a report by your engineer, giving estimates of the cost of supplying the district from two proposed sources: one, the water works of the city of Holyoke, from which the district could be supplied by gravity through pipes laid across the Connecticut River in the neighborhood of Smith's Ferry, and the other a system of tubular wells or a large well, to be located in the valley of Elmer Brook, a short distance east of Woodbridge Street, from which water would be pumped to a standpipe in the northerly part of the town and thence delivered to the district.

The Board has caused the locality to be examined by one of its engineers, and has carefully considered the plan and report presented. It is estimated by your engineer that the cost of obtaining a supply of water from the city of Holyoke would be much less than the cost of a supply taken from the ground in the valley of Elmer Brook, since the Holyoke supply would be delivered to the district by gravity, while a ground water supply from the Elmer Brook valley would have to be pumped; but, in the absence of definite information as to the charge that is likely to be made by the city of Holyoke for water supplied to the district, it is impracticable to determine definitely the comparative cost of the two plans.

There is no doubt, in the opinion of the Board, that a good ground water supply would be more desirable than the water of surface sources, such as those used by the city of Holyoke, and of the plans presented the Board is of the opinion that, all things considered, the most desirable plan for the district to adopt would be to obtain a supply of ground water either from Elmer Brook or some other suitable place within the limits of the town, if such a supply can be obtained at a reasonable cost. No careful investigation appears to have been made as yet to determine the practicability of obtaining an adequate supply of ground water for the district within the valley of Elmer Brook or elsewhere. While the conditions are very favorable, judging from surface indications, for obtaining an ample supply of good water from the ground near the brook east of Woodbridge Street, it is possible that an adequate supply of good water might be obtained at some other place in the town. The valley of Muddy Brook and the extensive plain southeast of the village should be carefully examined before a source of supply is finally selected, since, if a supply could be obtained at either of these locations, the cost of the works would doubtless be less than if the supply were taken from the neighborhood of Elmer Brook and a large saving might also be made in the cost of pumping.

The Board recommends that you make further investigations and tests of the ground by means of tubular wells at the locations mentioned, with a view to obtaining definite information as to the most favorable place in which to obtain a supply of water for the district; and the Board will, upon application, give you further advice in this matter when you have the results of these further tests to present.

OCT. 24, 1910.

To the Board of Water Commissioners of Fire District No. 2, South Hadley, Mass.

GENTLEMEN: — The State Board of Health received from you on Oct. 21, 1910, an application relative to a proposed water supply for Fire District No. 2 in the town of South Hadley, requesting the approval of the location of certain proposed wells in the valley of Elmer Brook, shown on plans submitted by your engineer, Mr. Lewis D. Thorpe, of Boston.

The plans provide for constructing two large wells about 300 feet apart in the valley of Elmer Brook, a little over half a mile northeast of the village of Moody Corner, as shown upon the State map, the wells to be approximately 25 feet in diameter and 12 feet in depth below the surface of the ground. The wells are to be located on the south side of the brook near the foot of the steep slope from the sand plain which borders the southwesterly side of Elmer Brook in this region. In the construction of the works it is proposed first to make an excavation at the location of well No. 2 somewhat larger in area than the proposed well and of the depth required, to measure the quantity of water which it is found necessary to pump in the course of this work and to make a further examination of the quality of the water as a guide to the further extension of the work. In case the wells proposed for construction in the beginning do not furnish a sufficient quantity of water, the plans provide for putting in similar additional wells or for laying a pipe line with open joints to collect the ground water in the valley of Elmer Brook farther up-stream.

The Board has caused the locality to be examined by its engineer and a sample of the water from a test well at the location of the proposed well No. 2 to be analyzed, and has considered the plans presented. The ground water in the valley of Elmer Brook, so far as can be judged from the single sample examined, is likely to be soft and in other respects of satisfactory quality for domestic purposes. Regarding the quantity of water obtainable in this valley, however, the tests thus far made are not sufficient to indicate very definitely whether the yield of the proposed wells or other collecting works is likely to be sufficient for the requirements of the district at all times.

Under the circumstances, the plan of making a large excavation at well No. 2 and obtaining further information as to the probable yield of the well and the quality of the water, appears to the Board to be a reasonable one to adopt; and as soon as the information furnished by this proposed test is available, the Board will give you further advice as to the plan of taking a water supply for the district from this locality.

SPENCER.

To the Board of Water Commissioners of the Town of Spencer. Nov. 3, 1910.

GENTLEMEN: — The State Board of Health received from you on Oct. 22, 1910, the following petition for the approval by the Board of the taking of a temporary water supply for the town: —

> Acting under authority of chapter 361 of the Acts of 1902, we hereby petition your Honorable Board that you approve the taking of the water from the pond known as Whittemore or Moose Pond, situated in said town of Spencer, as a proper source of water supply, to relieve the emergency now existing in said Spencer, owing to the unsafe and weakened condition of the 14-inch, cement lined, water main, leading from Shaw Pond, which is the source of supply for the town of Spencer.

You further state that it is the intention of the town to erect a temporary pumping station at the upper end of the pond on land owned by the town of Spencer, and to install an emergency pumping plant for use while a break is being repaired in the main leading from Shaw Pond to the town or while the main is being relaid.

In response to this petition the Board has caused the pond and its surroundings to be examined by one of its engineers and a sample of the water to be analyzed. The conditions affecting the quality of the water from Whittemore Pond do not appear to have changed materially since your previous petition for the use of this pond as a temporary source of water supply in 1905. Most of the buildings on the watershed of the pond are located at considerable distances from its shores and its tributaries, and the outbuildings formerly situated near the shore of the pond have been removed; but a barn near the highway at the northwesterly end of the pond is so situated that drainage from it pollutes the water. It will not be difficult to prevent pollution of the pond from most of the buildings now on the watershed, but it is desirable for the town to construct a sewer in Park Street and secure the connection with the sewers of all buildings on the streets near the upper end of the pond, so far as practicable. Before using the water all of the buildings within the watershed should be inspected and pollution of the pond from any of these places prevented.

With the suggestions herein contained for preventing the pollution of its waters, the Board approves the use of Whittemore Pond as a temporary source of water supply for the town of Spencer under the provisions of law relating to temporary water supplies.

SPRINGFIELD.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on Jan. 6, 1910, for preventing the pollution and securing the sanitary protection of the waters of Westfield Little River and its tributaries, used by the city of Springfield as a source of water supply.

STOCKBRIDGE.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on Sept. 1, 1910, for preventing the pollution and securing the sanitary protection of the waters of Lake Averic and its tributaries, used by the Stockbridge Water Company as a source of water supply for the town of Stockbridge.

TAUNTON.

To the Board of Water Commissioners of the City of Taunton. SEPT. 1, 1910.

GENTLEMEN: — The State Board of Health, acting under authority of chapter 467 of the Acts of the year 1907, recommends that no permits be granted for boating on that portion of Assawompsett Pond that lies west of a line between Green Point and a point about one-quarter of a mile east of the brook from Long Pond, except that owners of boats on this part of the pond be given permission to cross its waters from their boat houses or stations in a reasonably direct line when going to or coming from the main portion of the pond.

TOWNSEND (WELL).

To the Board of Health of the Town of Townsend. MAY 19, 1910.

GENTLEMEN: — In response to a request for an examination of the water of a well used for the supply of the high and grammar schools the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

It appears that complaint has been made of a bad taste in the water of this well since a heavy thaw last February, and that its use has been discontinued. An analysis of a sample of the water collected recently when compared with the results of an examination of last December shows that there has been a very great deterioration in the quality of the water and that imperfectly purified sewage is finding its way into the well.

The Board recommends that the further use of water from this well be prevented.

TYNGSBOROUGH (WILLOW DALE).

MAY 10, 1910.

To the Board of Health of the Town of Tyngsborough.

GENTLEMEN: — An examination of the summer resort known as Willow Dale, on the southeasterly shore of Tyng's Pond in Tyngsborough shows that the water supply for this resort is taken directly from the lake, the water of which is polluted at several points by sewage. In the opinion of the Board, it is essential for the protection of the health of those using this resort that a supply of good drinking water be provided and the use of water from the lake discontinued.

Provision should also be made for the disposal of the sewage from this resort in such a way that it will not create a nuisance or pollute the water of the lake.

The Board has also examined the sanitary conditions affecting the group of cottages located near the southerly end of the lake and finds that the water supply at some of them is badly polluted and unsafe for drinking. The water of the wells in this densely populated locality is exposed to pollution from the numerous vaults and cesspools which are necessarily located at no great distance, and it is necessary for the protection of the health of those living in this locality that a supply of good drinking water be provided. It is probable that a supply of good water can be obtained from the ground at some point in this region which would furnish all the water required both for these cottages and for the resort known as Willow Dale, at a reasonable expense.

WAKEFIELD.

DEC. 28, 1910.

To the Wakefield Water and Sewerage Board, Wakefield, Mass.

GENTLEMEN: — The State Board of Health received from you on Dec. 9, 1910, the following application for advice relative to the water supply of the town: —

> The Wakefield water and sewerage board desire to obtain the opinion of the State Board of Health in relation to the cause of the unpleasant taste

and odor of the water of Crystal Lake, Wakefield, whether it is deleterious to health, how it compares with the waters of other lakes of the state, and also, the best method of overcoming the same. As the town year closes on December 31, and the board desire to have this information before making the annual report, an early answer would be greatly appreciated.

Upon the receipt of this application the Board caused the lake and its watershed to be examined by one of its engineers, and has considered the results of numerous chemical and microscopical analyses of the water of the lake, covering a period of many years.

These analyses show that the water of the lake has always been affected in a greater or less degree by the presence of microscopic organisms, including at times some of those which have been known to impart to water a disagreeable taste and odor. Prominent among these is the organism *Asterionella,* which has been present at times in large numbers in the fall and spring. A far more serious trouble, however, which occurred in the summer of 1908, was caused by the organism *Anabœna,* which has rarely been present in this water in considerable numbers. At the time of its presence in 1908 it appeared in large numbers and affected the water very disagreeably during the latter part of the summer. The water has also at times been affected by the presence of small numbers of *Synura* and *Uroglena* in the colder season of the year, organisms which have often been known to cause very disagreeable tastes and odors, sometimes for long periods, when present in considerable numbers.

The cause of the appearance of these organisms in the waters of ponds and reservoirs is not definitely known, and no means of preventing their appearance has thus far been devised which may be used without danger of injuring the quality of the water. Water affected by them is not known to be injurious to health. Such organisms grow more abundantly in ponds and reservoirs having swampy drainage areas or containing considerable quantities of organic matter in their bottoms, as is the case with a large part of the area of Crystal Lake. These growths have also been found to be greater in waters in populous areas than in cases where the watersheds are sparsely populated. The watershed of Crystal Lake in proportion to its size contains a larger population unprovided with sewers than that of any other pond or lake now in use as a source of public water supply, and the population appears to have increased considerably in the last few years. There is no doubt that the presence of this population has a tendency to increase the growth of organisms in the water, and as the population on the watershed increases, the waters of the lake are likely to be affected more seriously by organic growths. Of the 48 ponds and reservoirs at present used as sources of public water supply in the State 41 contain less organic matter, as shown by the free and albuminoid ammonia, than Crystal Lake, 36 have less color and 37 supply a softer water.

The best practicable plan of removing the organic growths from this water and preventing the disagreeable tastes and odors which they produce is to filter the water through sand, and there is no doubt that by this method the objectionable tastes and odors can be efficiently removed at all times. Filtration would also be a further safeguard against danger of the effect of the pollution of the lake by the increasing population on its watershed.

While this appears to the Board to be the best plan of improving the water of Crystal Lake, the Board deems it important to call attention to the fact that the area of the watershed of Crystal Lake is somewhat less than a square mile, and while its storage capacity is very considerable, the present use of water by the town evidently already equals and possibly exceeds the capacity of the lake and its watershed in a series of very dry years. Under these conditions it is not desirable to make a further considerable outlay for filtering the water or making other improvement in the lake or its watershed until the town has considered the question of providing an additional water supply to meet its increasing requirements. It is very desirable, in the opinion of the Board, that the town begin without delay an investigation as to the best plan of providing an adequate supply of water for its requirements in the near future, taking into account at the same time the question of improving and preserving the quality of the water of Crystal Lake. The Board will assist you in the investigations as to an additional or improved water supply by supplying such information as it may have in the matter, and will upon request give you further advice as to the treatment of the water of Crystal Lake after the results of investigations as to an additional supply are available.

WESTFIELD (WESTFIELD STATE SANATORIUM).

DEC. 1, 1910.

To the Commission on Hospitals for Consumptives, ARTHUR T. CABOT, M.D., *Chairman, 3 Joy Street, Boston, Mass.*

GENTLEMEN: — The State Board of Health has considered your request of Nov. 7, 1910, for advice as to the desirability of acquiring additional lands, with the object of protecting the water supply now used by the Westfield State Sanatorium from possible pollution, and has examined the results of analyses of samples of water from the wells from which the supply of the institution has been drawn during the year 1910.

It appears that the population at the institution during the past few months has been in the neighborhood of 200, and that the quantity of water used has amounted to about 20,000 gallons per day. This quantity has apparently been obtained from the wells without serious difficulty during the very dry months of the past summer and fall.

The results of the analyses of samples of water from the wells collected during the past six months are similar to those of the samples collected last year, though there has been an improvement, especially as to the quantity of iron present in the water. The water still shows evidence of previous pollution, which, judging from the results of recent investigations, is caused very largely by the pollution of the ground water at and in the neighborhood of the dwelling house near the highway northwest of the wells. The experience of the past year indicates that, if the present sources of water supply should be properly protected, an adequate quantity of water of suitable quality for the requirements of the institution, as at present developed, can be obtained from these wells, but if the water should not be protected and the quality should become objectionable, the cost of securing an adequate supply of good water from some other source would be a serious one.

Considering the circumstances, it is advisable, in the opinion of the Board, for the trustees to secure control of the dwelling house and land north of the wells between the highway and the brook, and when control has been secured, the occupation of the dwelling house and the cultivation of the land should be discontinued.

WESTON.

DEC. 1, 1910.

To the Weston Water Company, Weston, Mass.

GENTLEMEN: — The State Board of Health received from you on Oct. 27, 1910, through your engineer, an application for the advice of the Board relative to taking water for the supply of the town of Weston from the ground southwest of Stony Brook near the Kendal Green railroad station, and in response to this application the Board has caused the locality to be examined by its engineer and samples of the water of the wells to be analyzed.

It appears that during the past summer five test wells were driven at this place, which is about 600 feet up-stream from the point at which the test was made last year, and that water was pumped from these wells for the supply of the town for a period of about seven weeks beginning September 4, the estimated rate of pumping being about 120,000 gallons per day. The results of the analyses of the samples of water sent in by you during the time the wells were in use show that this water is of good quality for domestic purposes and free from an excess of iron. The information as to the lowering of the ground water and its recovery at the end of the test indicates, in connection with other circumstances, that a sufficient supply of water for the requirements of the town of Weston can probably be obtained from the ground in this locality, and, in the opinion of the Board, the proposed source is an appropriate one from which to take water for the supply of the town of Weston. If it is decided to take water from this source, it will be desirable for the water company to secure control of a considerable area of land about the wells in order to protect the purity of the water.

WESTPORT (WESTPORT MANUFACTURING COMPANY).

SEPT. 1, 1910.

To the Westport Manufacturing Company, Westport, Mass.

GENTLEMEN: — In response to your request for an examination of the wells used for the supply of your mills and tenement houses in Dartmouth and Westport, the Board has caused the locality to be examined by one of its engineers and samples of water from ten of the wells in the neighborhood of the mills to be analyzed.

The results of the examination of three wells near Mill No. 2 and seven wells near Mill No. 1 show that all of these wells are located in the immediate neighborhood of dwelling houses, with sources of pollution at no great distance. The results of the analyses show that the waters of all of these wells have at some time been polluted and have not subsequently been thoroughly purified in passing through the ground before entering the wells. While the waters of some of these wells may not be injurious for drinking at the present time, a change in the conditions affecting their pollution may at any time render the water of any of them unsafe.

At present the water of the well used at the office and in Mill No. 1 contains greater impurities than the others and cannot be regarded as safe for drinking. Some of the others approach very nearly to this condition.

Under the circumstances, the Board recommends that a supply of water from a source of known purity be provided for use in these mills and tenements.

OCT. 6, 1910.

To the Westport Manufacturing Company, Westport, Mass.

GENTLEMEN: — In accordance with your request of Sept. 7, 1910, for an examination of two wells from which you might obtain a supply of water for the village, the Board has caused the wells and their surroundings to be examined and samples of their waters to be analyzed.

The results of the analyses show that the waters of these wells do not contain as much organic matter as those of the wells previously examined, but both wells show evidence of considerable previous pollution, and while these waters may not be injurious for drinking at the present time, there are sources of pollution at no great distance and a change in the conditions affecting their pollution may at any time render these waters unsafe. Under the circumstances the Board is unable to recommend the use of either of these wells as a source of water supply for the village.

In addition to the foregoing, the Board has advised the following cities, towns and persons relative to spring waters, waters used for the supply of factories, public wells or wells used by a number of families; but as these matters are for the most part of minor importance, the communications of the Board in these cases have not been printed. Copies of them are on file in the office of the Board.

Acton, well in South Acton.
Acton, well in West Acton.
Attleborough, well of J. M. Fisher Company.
Attleborough, well of Frank Mossberg Company.
Beverly, wells of United Shoe Machinery Company.
Braintree, water supply of Rice & Hutchins.
Cambridge, well of Y. M. C. A.
Danvers, spring.
Dartmouth, wells at Lincoln Park (two).
Gloucester, well in West Gloucester.
Hamilton, well at Asbury Grove.
Harvard, water supply of Hildreth Bros.
Harvard, well at grammar school.
Lancaster, spring at Bolton annex of Lancaster Industrial School.
Lexington, spring of Jefferson Union Company.
Lynn, springs.
Norfolk, wells of American Felt Company.
North Adams, well of Barber Leather Company.
North Andover, water supply of Davis & Furber Company.
Northborough, well of Whiting Manufacturing Company.
Peabody, King Philip Spring.
Pittsfield, water supply of Pittsfield Junction.
Rockport, well.
Salem, Sutton Spring.
Salem, well of Salem Laundry Company.
Stoughton, well of Plymouth Rubber Company.

Sutton, well of Army and Navy Cotton Duck Company.
Taunton, well.
Walpole, well at mill of F. W. Bird & Son.
Weston, well of Hook & Hastings Company.

ICE SUPPLIES.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to sources of ice supply: —

ASHBURNHAM.

MAY 19, 1910.

To the Board of Selectmen of the Town of Ashburnham.

GENTLEMEN: — In accordance with your request for an examination of the ice harvested in Ashburnham and advice as to its quality, the Board has caused Brigham's Pond, which appears to be the main source of ice supply, to be examined and samples of ice collected from an ice-house on the shore of the pond to be analyzed.

The samples examined consisted in part of clear ice and in part of snow ice, the thickness of snow ice upon one of the samples analyzed being about 5 inches. The analyses show that the snow ice is of very poor quality. It contained a large number of bacteria and a much larger quantity of organic matter than is found in good ice and should not be used where it may come in contact with food or drinking water. The samples of clear ice were found to be of good quality, and it is probable, in the opinion of the Board, that if the snow ice, including the first inch of clear ice that formed upon the pond, should be removed before using, the clear ice beneath the first inch might safely be used for domestic purposes, provided all ice containing particles of foreign matter were rejected.

There is a considerable population about the shores of the pond and along the stream above it, and the water is polluted by sewage from factories and buildings near the pond and drainage from the populated territory about it. While, by carefully observing the precautions which have been suggested, a portion of the ice harvested under the conditions which existed during the past winter may probably be used with safety, the pond is not, in the opinion of the Board, a safe source from which to take ice for domestic purposes under existing conditions, and until its direct pollution by sewage is prevented, the Board recommends that its further use as a source of ice supply be discontinued.

CONCORD.

FEB. 3, 1910.

To Mr. JOHN M. KEYES, *Chairman Board of Health, Concord, Mass.*

DEAR SIR: — In response to your request for an examination of the ice taken from Hayward's Pond in Concord and advice as to its quality, the State Board of Health has caused the pond and its watershed to be examined and samples of the water and ice to be analyzed.

The results of the analyses show that the ice contained more organic matter than is found in good ice, the large quantity of organic matter probably being due to the snow ice of which it is partly composed. This ice can probably be used with safety for domestic purposes, provided the snow ice and the first inch of clear ice that formed upon the pond be removed before using and all ice containing particles of foreign matter rejected.

LEXINGTON.

FEB. 3, 1910.

To the Board of Health of the Town of Lexington.

GENTLEMEN: — In accordance with your request for an examination of the ice of Simond's Pond in Lexington and advice as to its use for domestic purposes, the Board has caused the pond and its surroundings to be examined and a sample of the ice to be analyzed.

The conditions about the pond have been improved since a previous examination, and the results of an analysis of a sample of the ice show that its quality is better than last year. In the opinion of the Board, this ice can safely be used for domestic purposes, provided that all snow ice, including the first inch of clear ice that forms upon the pond, be removed before using and that all ice containing particles of foreign matter be rejected, as recommended last year.

MEDFORD.

FEB. 3, 1910.

To the Board of Health of the City of Medford.

GENTLEMEN: — In response to your request for an examination of the ice of a flooded clay pit between Stearns and College avenues and Main Street in Medford, north of Buzzels Lane, and advice as to its quality, the Board has caused the clay pit and its surroundings to be examined and samples of the water and ice to be analyzed.

The results of the examination show that several surface drains in adjacent streets discharge upon ground sloping toward the clay pit, and that there are other sources of pollution in the neighborhood, including a dump for city refuse and another used for the disposal of snow from the streets.

An analysis of a sample of water collected from the clay pit shows that it is badly polluted, and the snow ice, of which the ice upon the pond is now largely composed, contains a greater quantity of organic matter than is found in good ice. A sample of the clear ice was found to be of good quality, but the depth of clear ice is small.

Considering the pollution to which this pond is exposed, the Board is of the opinion that it is an unsafe source from which to take ice to use for domestic purposes where it may come in contact with food or drinking water.

MELROSE.

APRIL 7, 1910.

To the Board of Health of the City of Melrose.

GENTLEMEN: — In accordance with your request, the State Board of Health has caused an examination to be made of Long Pond, Stillman's Pond and the ponds of the East Side Ice Company, so called, and samples of the water and ice from these sources to be analyzed.

The results of the analyses of samples of ice from these sources indicate that the clear ice is of good quality for domestic purposes. The Board recommends that all snow ice, including the first inch of clear ice that formed upon the pond, be removed before using, and all ice containing particles of foreign matter rejected.

The condition of Towner's and Swain's ponds was examined last year in response to a request from the authorities of the city of Malden. The conditions affecting the ice from these sources do not appear to have changed since that time, and a copy of the advice of the Board with reference to these sources is enclosed herewith.

If these directions are followed, the Board is of the opinion that the remaining ice from these sources may safely be used for domestic purposes.

NEWTON.

FEB. 3, 1910.

To FRANCIS GEORGE CURTIS, M.D., *Chairman, Board of Health, Newton, Mass.*

DEAR SIR: — In response to your request for an examination of Hammond's Pond in Newton and advice as to the quality of the ice taken therefrom the Board has caused the pond to be examined and samples of the water and ice to be analyzed.

The watershed is thinly populated and contains but few dwelling houses, most of which are quite remote from the pond. A sewer now in process of construction will soon be available for removing the sewage from most of the houses within the watershed. The pond has a muddy bottom and a considerable area of swamp within its watershed and the water contains a large quantity of organic matter. At the present time there is a considerable depth of snow ice upon the pond, the greater portion of which is being removed before harvesting. Analyses show that the snow ice contains a large quantity of organic matter and that the ice after harvesting, which still includes a thin layer of snow ice, also contains a larger quantity of organic matter than is usually found in good ice. The clear ice beneath the snow ice was found to contain much less organic matter than the other samples. The number of bacteria in all cases was low, and, judging from the results of these analyses, it does not appear that the ice as harvested is likely to be dangerous or objectionable for domestic use.

The Board recommends that hereafter all snow ice, including the first inch of clear ice that forms upon the pond, be removed and only the clear ice retained for use. If these precautions are observed and all ice containing particles of foreign matter rejected this pond will continue, in the opinion of the Board, to be a safe source of ice supply under present conditions.

NORTHAMPTON.

JUNE 2, 1910.

To the Board of Health of the City of Northampton.

GENTLEMEN: — In response to your request for an examination of the ice supplied by the Meadow City Ice Company in the city of Northampton and advice as to its quality, the Board has caused the source of supply to be examined and samples of the water and ice to be analyzed.

The results of the examination show that the ice is taken from a small pond in the southerly part of the city, and there appear to be no buildings in the neighborhood of the pond or upon its watershed so situated as to cause pollution of the pond. An examination of the ice collected from an ice-house near the shores of the pond shows that it is of good quality, and, in the opinion of the Board, ice from this source may safely be used for domestic purposes.

QUINCY.

APRIL 7, 1910.

To the Board of Health of the City of Quincy.

GENTLEMEN: — In accordance with your request of Jan. 8, 1910, for an analysis of a sample of water from Manet Lake at Hough's Neck, the Board has caused a further examination of the lake to be made and a sample of the water to be analyzed. The results of the analysis show that the water is very highly colored and contains an excessive quantity of organic matter.

A sample of the best ice which it was practicable to obtain from the lake was also analyzed at this time, and the results show that its character is about the same as that of samples previously analyzed from this source, concerning the quality of which you have already been advised. An examination of the ice stored in the ice-house near the shore of the lake, and apparently harvested from the lake during the past winter, shows that much of it contains filaments of aquatic plants and weeds or similar foreign matter.

The Board knows of no practicable way to secure from this lake ice which may safely be used for domestic purposes where it may come in contact with food or drinking water; and there does not appear to be any practicable way of improving the condition of the lake to such an extent that ice of good quality can be obtained from it in the future.

SALISBURY.

APRIL 7, 1910.

To the Board of Health of the Town of Salisbury.

GENTLEMEN: — The attention of the State Board of Health having been called to a pond located about one mile east of the village of Salisbury and 500 feet south of the beach road, so called, which is said to be used as a source of ice supply, the Board has caused the pond and its surroundings to be examined and samples of the water and ice to be analyzed.

The results of the examination show that the pond is shallow and that the water contains a large quantity of organic matter. The ice as harvested contained about 2 inches of snow ice, and the quantity of organic matter found in a sample of this ice was much greater than is found in good ice. There are no sources of pollution in the immediate neighborhood of the pond, however, and it is probable, in the opinion of the Board, that ice harvested from this source may safely be used for domestic purposes, provided that the first inch of ice that forms upon the pond, including all snow ice, be removed before using, and that all ice containing particles of foreign matter be rejected.

WHITMAN.

FEB. 3, 1910.

To Mr. J. E. WHIDDEN, *Whitman, Mass.*

DEAR SIR: — In response to your request for advice as to the use of ice cut from Hobart's Pond in Whitman for domestic purposes, the Board has caused the pond and its surroundings to be examined and samples of the water and ice to be analyzed.

The results of the analyses show that the water of Hobart's Pond is considerably polluted and contains a large quantity of organic matter, and that the snow ice is of very objectionable quality, partaking largely of the character of the pond water. The clear ice beneath the snow ice is of good quality.

In the opinion of the Board the only plan by which it is practicable to obtain from this pond ice which may safely be used for domestic purposes is to remove from the ice, when harvested, all snow ice, including the first inch of clear ice that formed upon the pond, and to reject all ice containing particles of foreign matter. If these precautions are observed the clear ice may be used with safety for domestic purposes.

WOBURN.

FEB. 3, 1910.

To Mr. MILFORD C. HOPPER, *Woburn, Mass.*

DEAR SIR: — In response to your request for an examination of the ice of Hopper's Pond and advice as to its quality, the State Board of Health has caused the pond to be examined and a sample of the ice therefrom to be analyzed.

The results of the analysis show that the clear ice from this source is of good quality for domestic purposes. The Board recommends that all snow ice, including the first inch of ice that forms upon the pond, be removed before using and that all ice containing particles of foreign matter be rejected.

SEWERAGE AND SEWAGE DISPOSAL.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to sewerage and sewage disposal: —

AMHERST.

FEB. 3, 1910.

To the Board of Selectmen of the Town of Amherst.

GENTLEMEN: — The State Board of Health received from you on Jan. 15, 1910, an application for advice as to a proposed system of sewage disposal for the sewage discharged at the Dana Street outlet, so called, accompanied by plans of the proposed works. The plans provide for collecting the sewage in a tank having a capacity of a little less than 3,000 gallons, to be located at a point about 340 feet above the present sewer outlet, from which the sewage is to be discharged upon four filter beds, two of which — having an area of about 0.12 of an acre — are to be constructed in the beginning.

The soil at the location of the filtration area is not suitable for the purification of sewage by intermittent filtration and the filter beds are to be constructed of sand or gravel hauled to this location from a sand bank at a distance of a little less than a mile. The Board has caused the locality to be examined by one of its engineers and has considered the plans presented.

The quantity of sewage discharged at the Dana Street outlet at the present time is very small, there being only about seven dwelling houses connected with the sewer and ten or twelve in the district likely to be served by it, and the area of filter beds which it is proposed to construct in the beginning is ample for present needs.

If the filter beds are constructed under proper supervision with sand or gravel suitable for the purpose and the underdrains are properly laid, the filter beds will be capable of purifying the sewage satisfactorily so that the underdrainage may be discharged into a neighboring watercourse without objection. It is important for the successful operation of the dosing tank that a properly designed siphon be provided when it is constructed, which will empty the tank at each discharge. While filter beds at the proposed location can be operated without creating objectionable conditions in the neighborhood if they receive proper care, it is not desirable to attempt to dispose of a much larger quantity of sewage in this locality, and the Board recommends that in planning for a general system of sewage disposal for the town provision be made, if practicable, for disposing of the sewage from the Dana Street outlet in connection with that from the other portions of the town and the use of the filter beds now proposed discontinued.

OCT. 6, 1910.

To the Board of Selectmen of the Town of Amherst, MR. THOMAS J. THURSTON, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on Sept. 6, 1910, a petition for the approval by the Board under the provisions of chapter 49, section 1, of the Revised Laws, of the purchase or taking of certain lands in the town of Amherst for the purification and disposal of sewage, accompanied by a plan and description of the lands which it is proposed to acquire which are situated in the southeasterly part of the town of Amherst near Fort River.

In response to this petition the Board, after having caused an examination of the lands to be made by one of its engineers, gave a public hearing as required by law at its office, Room 143, State House, on Thursday, Oct. 6, 1910, at 11 A.M., due notice of said hearing having been given by publication in the newspapers of the town of Amherst and of the city of Springfield. After the hearing, at which no one appeared to oppose the taking of the lands in question by said town, the Board on consideration voted to approve the purchase or taking of the lands indicated upon the plan submitted for the purification and disposal of sewage, said lands, — which aggregate about 7⅓ acres in area, — being bounded, measured and described as follows: —

Land of Abbie Hastings: Beginning at a highway bound stone on the southerly side and at the easterly end of the highway, thence south 58° 9′ east one hundred and eighty-eight (188) feet by a fence, said fence being the boundary of a lane on land of Abbie Hastings, to a stake, said stake being forty-four (44) feet westerly of a fence which divides two lots of the said Abbie Hastings; thence south 22° 21′ west six hundred and sixty-eight (668) feet by land of Abbie Hastings to a stake and stones; thence north 69° 19′ west two hundred and eighty-eight (288) feet by land of Abbie Hastings to another stake and stone; thence north 5° 41′ east two hundred and twelve (212) feet by a fence and land of Henry Juckett to an elm tree; thence north 63° 37′ west forty-seven (47) feet by a fence and land of said Juckett to another elm tree; thence north 70° 27′ west thirty-seven (37) feet by a fence and land of said Juckett to another elm tree and corner of land of Henry Juckett and Abbie Hastings; thence north 3° 53′ east two hundred and seventy-two (272) feet by land of Abbie Hastings to a stake and stones; thence north 21° 52′ east two hundred and eighty-three (283) feet to the west post of a pair of bars in a fence on the highway first mentioned in this description; thence south 61° 14′ east three hundred and thirty-four (334) feet by a fence and by the westerly side of the highway first mentioned to the point of beginning, said lot containing about seven acres of land.

Land of Henry Juckett: Beginning at an elm tree in a corner of the land of Henry Juckett and running south 5° 41′ west two hundred and twelve (212) feet by a fence, said fence and land of Abbie Hastings; thence north 69° 19′ west seventy-three (73) feet by land of Henry Juckett to a stake and stones; thence north 3° 53′ east two hundred and sixteen (216) feet by land of said Henry Juckett to an elm tree; thence south 70° 27′ east thirty-seven (37) feet by a fence and land of Abbie Hastings to another elm tree; thence south 63° 37′ east forty-seven (47) feet by a fence and land of Abbie Hastings to the point of beginning, said lot containing about one third of an acre of land.

Oct. 24, 1910.

To the Board of Selectmen of the Town of Amherst.

Gentlemen: — The State Board of Health received from you on Oct. 6, 1910, an application for advice as to plans of filter beds for the purification of the sewage now discharged into Fort River from the town of Amherst, accompanied by plans of the filters, submitted by your engineer.

The plans provide for the construction of six filter beds and two small sludge beds having an aggregate area of two acres, to be located on the land already acquired for the purification and disposal of sewage in the neighborhood of your present main sewer outlet into Fort River. According to the plans, the filter beds are to be constructed in part upon an area of sandy land lying considerably above the level of the river and in part upon low ground adjacent to the river, using material taken from the higher lands, the soil of which, while much of it is somewhat fine, is suitable for the purification of sewage by intermittent filtration. The plans provide for filters having a depth of from 4 to 4½ feet, to be underdrained by a main underdrain in each filter and lateral drains 26 feet apart in all of the beds. The present tanks are to be used as settling tanks, the sludge from which is to be discharged upon two small sludge beds located at the southerly end of the filtration area near the river.

The Board has caused the locality to be examined by one of its engineers, the quantity and character of the sewage at present discharged at the Fort River outlet to be determined and has considered the plans presented. A measurement of the flow of sewage made on October 6 and 7 last, after an unusually dry period of several weeks' duration, at a time when the leakage into the sewers was probably at a minimum, shows that the quantity discharged at that time amounted to about 140,000 gallons per day. At other times measurements have shown that the quantity of sewage flowing from this outlet is much larger, the maximum summer flow probably being at times as much as twice the quantity found at the recent observations. The measurements available indicate that there is a large leakage of ground water into the sewers and it is possible that considerable surface water finds its way into them.

An analysis of the sewage shows that at the present time it differs but little from ordinary town sewage, though containing probably somewhat less organic matter than is usually the case.

In the opinion of the Board, the proposed filters, if constructed with due care and properly maintained, are capable of purifying adequately the sewage discharged at this outlet during the drier portion of years of ordinary rainfall, while the population using the sewers is no larger than at the present time. It is unlikely that these filters will be capable of purifying all of the sewage satisfactorily during the winter and spring, and it is doubtful whether they can care for all of the sewage flowing from the town in wet seasons, even in the warmer part of the year. Their construction will prevent a large part of the pollution of Fort River, especially in the summer season, and the Board recommends that the proposed filters be completed as soon as practicable.

It is advisable that plans be made in the early future either for reducing the flow in the sewers by eliminating ground drainage and surface water, if there are any connections or openings through which the surface water is admitted to the sewers, or for enlarging the filtration area to such an extent as may be necessary to provide for the treatment of all of the sewage at all times.

ATTLEBOROUGH.

APRIL 9, 1910.

To the Sewerage Committee of the Town of Attleborough.

GENTLEMEN: — The State Board of Health received from you on March 22, 1910, an application under the provisions of chapter 157 of the Acts of the year 1909, for the approval of a proposed system of sewerage and sewage disposal for the town of Attleborough, which provides for the purification of the sewage upon filter beds lying partly in the town of Attleborough and partly in the town of Seekonk, south of the Providence Division of the New York, New Haven & Hartford Railroad, and between said railroad and the Ten Mile River, as provided in said chapter 157; and in accordance with the further provisions of said chapter the State Board of Health gave a hearing upon the proposed plans at its office, Room 143, State House, on April 7, 1910, after giving notice of the hearing by publishing the same in the Attleborough "Sun." At this hearing no person appeared to object to the approval of the plans presented. After the hearing the Board voted to approve the proposed system of sewerage and sewage disposal, as shown upon the plans submitted, the general plan of the system of sewers and disposal works being shown upon three sheets, bearing respectively the following titles: —

(1) Attleborough Sewerage. Plan Showing Location of Sewers and Filtration Field. Attleborough, Mass. March 1910. J. J. Van Valkenburgh, C. E. Scale — 1 inch = 500 feet.

(2) Attleborough Sewerage. Topographical Plan of Filtration Field, Showing Location of Proposed Filters and Trunk Sewer. Attleborough, Mass. March 1910. J. J. Van Valkenburgh, C. E. Scale — 1 inch = 80 feet.

(3) Attleborough Sewerage. Plan of Filtration Areas. Showing Systems of Distribution and Underdrainage. Attleborough, Mass. March 1910. J. J. Van Valkenburgh, C. E. Scale — 1 inch = 40 feet.

BOSTON.

SEPT. 12, 1910.

Mr. L. K. ROURKE, *Superintendent of Streets of the City of Boston.*

DEAR SIR: — The State Board of Health has considered your communication of August 26 requesting advice as to whether "the condition of Boston Harbor would warrant the city and State making an experiment in the disinfection of sewage with chloride of lime for a sufficiently long time to allow of samples being taken of the waters of the harbor in various places and submitted to bacterial analysis to see whether a substantial improvement worth what it costs, can be effected in this way."

A very thorough examination was made of the condition of the water in all parts of the harbor in 1905. The results of chemical and bacterial examinations made at that time, which covered all parts of the harbor and included tests of the waters of the sea outside, showed that the most polluted section of Boston Harbor at that time was the portion extending from the neighborhood of Governor's Island and City Point to the mouths of the Charles and Mystic rivers. The least polluted sections were the large area known as Hingham Bay and the region north of the main ship channel between East Boston and Deer Island. The greatest pollution in small areas was found in the areas covered by sewage discharged at the main sewer outlets at Moon Island, Deer Island and Peddock's Island, — the area covered by sewage at Moon Island being much larger than in the case of the other outlets. In the Neponset estuary, also, the pollution was very marked, due no doubt to the pollution of the Neponset River above.

The results of the analyses also showed that the pollution detectable by chemical and bacterial analysis in the region about the sewer outlets was confined practically to the area visibly affected by sewage. The area affected by the sewage discharged at Peddock's Island was very limited, and the area affected at Deer Island under ordinary conditions was not very extensive. The discharge at Moon Island, which is confined to about two hours on each ebb tide, is very much larger while it continues than in the case of the other outlets where the discharge is continuous, and the area affected by the sewage at Moon Island during and for a time after the period of discharge was much larger than at the other outlets.

There has been no material change in the conditions since the examinations of 1905 were made, except that the quantity of sewage discharged at the Peddock's Island outlet has been considerably increased. Examinations of this outlet, however, show that the area affected by sewage continues to be very limited; in fact its location is difficult to find at any time. The sewage discharged at Deer Island and Peddock's Island flows into swift tidal currents, becomes quickly mixed with a great volume of water and on each outgoing tide is carried completely to sea and dispersed. The evidences of the careful examinations of 1905 indicate that at Moon Island also the sewage, when discharged at the proper time, affects only the waters of the channels into which it is discharged. Under the circumstances it does not appear, upon these examinations, that the discharge of sewage at the three main sewer outlets mentioned is causing serious injury to the waters of the harbor generally, the effect of the discharge of sewage at these outlets being confined to certain quite definite areas.

Aside from these well-defined areas the most seriously polluted portion of Boston Harbor, as shown by the very thorough examinations referred to, is the inner harbor and its various arms, including the mouths of the rivers and estuaries; and the results of the examinations show that this pollution is not due to the discharge of sewage at the Moon Island or at either of the other main outlets. This pollution is due to the discharge of sewage mingled with storm water at the various sewer outlets at times of storm, of which large quantities find their way into the waters along the shores of the harbor at times of heavy rain, and to matters discharged or thrown into the water from shipping and from buildings, wharves and lands along the waterfront. These polluted waters border upon the shores of the more densely populated parts of the city, while the sewage discharged at the three main harbor outlets is confined to the currents into which it is discharged, by which it is removed from the harbor and dispersed before reaching any thickly populated shore.

Under the circumstances it is not likely that the disinfection of the sewage discharged at the Deer Island and Peddock's Island outlets would have a noticeable effect on the condition of the waters of Boston Harbor generally, nor is it likely, assuming the sewage discharged at the Moon Island outlet to be disinfected as thoroughly as practicable, that such treatment would have a material effect upon the harbor waters outside of the currents into which the sewage is discharged. The results of the examinations of the sewer outlets and harbor waters show that to the improvement of the condition of the more seriously polluted portions of the harbor waters, which are adjacent to its most densely populated shores, the treatment of the sewage at the main sewer outlets in the manner proposed would contribute but little.

BRAINTREE.

FEB. 3, 1910.

To the Sewerage Committee of the Town of Braintree.

GENTLEMEN: — The State Board of Health received from you on Jan. 22, 1910, an application for advice as to a proposed system of sewerage and sewage disposal for the town of Braintree, accompanied by a report of your engineer, W. S. Johnson, C.E., of Boston, describing the conditions affecting the disposal of the sewage of the town and giving an outline of the plan recommended.

This plan provides for collecting the sewage of the central and southerly portions of the town, including the villages of Braintree and South Braintree, into a main sewer beginning in South Braintree and passing through the valley of the Monatiquot River to Braintree and thence through the divide to the valley of the Town River in Quincy, whence, it appears, the sewage will flow by gravity to the high-level sewer of the South Metropolitan District.

The lower parts of the town, including the village of East Braintree, are too low to be served by the proposed main sewer by gravity, and under the proposed plan the sewage from these districts would be pumped into the main sewer in the neighborhood of Braintree or it could, if desirable, be disposed of at some future time in connection with the sewage of the neighboring town of Weymouth.

The Board has caused the locality to be examined by its engineer and has carefully considered the plan presented. The main sewer as proposed in the valley of the Monatiquot River leading to Quincy would provide for the collection of all of the sewage of the central and southerly portions of the town where the need of sewerage is greatest at the present time. The plan of collecting the sewage of the lower portions of the town, including East Braintree, and pumping it into the general system is a satisfactory method of providing for those districts under the existing conditions.

The plan of disposing of the sewage by discharging it into the high-level sewer of the Metropolitan system appears to be the best one available under the circumstances, and the proposed plan in general is, in the opinion of the Board, an appropriate one for the sewerage of the town of Braintree.

It is very important, in the opinion of the Board, that sewerage facilities be provided with as little delay as practicable in the neighborhood of Little Pond, where one of the sources of water supply of the town is located.

BROCKTON.

JULY 7, 1910.

To the Board of Sewerage Commissioners of the City of Brockton, MR. CHARLES R. FELTON, *Clerk.*

GENTLEMEN: — The State Board of Health received from you on June 20 a petition for the approval by the Board, under the provisions of chapter 49, section 1, of the Revised Laws, of the purchase or taking of certain lands in the city of Brockton for the purification and disposal of sewage, accompanied by a plan and description of the lands which it is proposed to acquire, which are situated in the city of Brockton adjacent to the present filter beds of that city and bordering the boundary line between Brockton and West Bridgewater.

In response to this petition the Board, after having caused an examination of the lands to be made by one of its engineers, gave a public hearing, as required by law, at its office, Room 143, State House, on Thursday, July 7, 1910, at 11 A.M., due notice of said hearing having been given by publication in the newspapers of the city of Brockton. After the hearing, at which no one appeared to oppose the taking of the lands in question by said city, the Board upon consideration voted to approve the purchase or taking of the lands indicated upon the plan submitted for the purification and disposal of sewage, said lands, which aggregate about 75 acres in area, being bounded, measured and described as follows: —

The first parcel of land, belonging to the City of Brockton, lies between Liberty street and Pearl street, and northerly from land taken for a sewerage force main, and is bounded as follows: Beginning at the northeasterly corner of land of Albert Manley on the westerly side of Liberty street; thence westerly by a stone wall 122 ft.; thence southerly by a wall about 121 ft.; thence westerly by a wall about 68.5 ft.; thence southerly by a wall about 196.5 ft. to a stone bound marking the northerly line of land taken for a force main by the City of Brockton; thence westerly by the northerly line of said land taken for a force main about 953 ft. to land now used by permission of the State Board of Health for filter beds; thence northerly by the easterly side of the filter beds about 165 feet; thence northwesterly about 400 feet to the easterly line of Pearl street; thence northerly by the easterly line of Pearl street about 165 feet to the southwesterly corner of land of Coweeset cemetery; thence easterly by land of Coweeset cemetery 322 feet to the southeasterly corner thereof; thence northerly 475 feet by the easterly line of said cemetery to land of Jonas Reynolds; thence easterly by land of said Jonas Reynolds about 865 feet to the westerly line of Liberty street; thence southeasterly by Liberty street about 310 feet to land of Albert Manley and the point of beginning. Said parcel contains 19 acres of land.

The second parcel of land, belonging to the City of Brockton, is situated on the westerly side of Liberty street and bounded and described as follows: Beginning at the northeasterly corner of said lot, on the westerly side of Liberty street, thence westerly about 75 feet by land of Albert Manley; thence southerly by land of Albert Manley about 81 feet to the northerly line of land used as a force main; thence easterly by the northerly line of said force main about 91 feet to the westerly line of Liberty street; thence northerly by the westerly line of Liberty street about 100 feet to the point of beginning. Said parcel contains 7,480 square feet of land.

The third parcel of land, belonging to Albert Manley, is bounded and described as follows: Beginning at the southeasterly corner of the described lot, on the westerly side of Liberty street, at the northeasterly corner of land of the City of Brockton; thence westerly by land of said City of Brockton about 75 feet; thence southerly by land of said City of Brockton about 81 feet to the northerly line of land used as a force main; thence westerly by the northerly line of land used for a force main about 206.5 feet to a stone wall; thence northerly by a stone wall about 196.5 feet; thence easterly by a stone wall about 68.5 feet; thence northerly by a stone wall about 121 feet; thence easterly by a stone wall about 122 feet to the westerly line of Liberty street; thence southerly by the westerly line of Liberty street about 258 feet to the point of beginning. Said parcel contains 1 acre 19,500 sq. ft. of land.

The fourth parcel of land, belonging to the City of Brockton, situated on the southerly side of West Chestnut street and the easterly side of Liberty street, is bounded and described as follows: Beginning at the intersection of the southerly line of West Chestnut street with the easterly line of Liberty street; thence easterly by the southerly line of West Chestnut street about 1,994 feet to land of the Longview Park Associates; thence southerly by land of said Associates about 429 feet; thence easterly about 60 feet; thence southerly about 170 feet to the southerly line of a proposed street called Tupelo street; thence easterly by the southerly line of said Tupelo street about 341 feet to the westerly line of another proposed street called Berlin street; thence southerly by the westerly line of Berlin street about 83 feet; thence in a southeasterly direction about 44 feet to the northwesterly corner of land now or formerly of Lizzie M. Johnson; thence southeasterly by land of said Lizzie M. Johnson about 367 feet to land now or formerly of L. E. and E. Copeland; thence westerly by land of said L. E. and E. Copeland and land of C. H. Dunbar Heirs about 487 feet; thence northerly about 143 feet; thence in a northwesterly direction by land of said Dunbar Heirs about 337 feet to the northeast corner of land of L. E. and E. Copeland; thence westerly by land of said Copeland about 328 feet; thence northerly 18.5 feet; thence westerly by land of said Copeland about 449 feet; thence southerly by land of said Copeland about 333 feet to the line between Town of West Bridgewater and the City of Brockton; thence westerly by said line about 954 feet to the easterly line of Liberty street; thence northerly by the easterly line of Liberty street about 1165 feet to the point of beginning. Said parcel contains about 54 acres.

CANTON (PLYMOUTH RUBBER COMPANY).

To the Plymouth Rubber Company, Canton, Mass. SEPT. 1, 1910.

GENTLEMEN: — The State Board of Health received from you on August 18 a communication stating that in the course of the manufacture of rubber at your Canton works you intend to do considerable washing and grinding, and requesting the opinion of the Board as to whether the drainage system installed in the Canton works is sufficient for the proper treatment of the waste. In response to this application the Board has caused an examination of the works to be made and finds that it is proposed to discharge the waste liquors from the boiling and washing of stock through concrete trenches located beneath the machines, whence the waste, after passing through fine screens, will flow to settling tanks and thence to the river. It appears that a large quantity of water is to be used in cooling the various rolls and that this water is also to be discharged into the troughs beneath the machines and mingled with the heavier wastes on their way to the settling tanks.

Under the existing conditions it is impracticable to obtain samples of the various wastes which will show definitely their probable character, but, so far as can be judged from examinations of the wastes from your present works at Stoughton, it is unlikely that the heavier wastes from the new mill at Canton will be purified to a sufficient extent by sedimentation to prevent objectionable pollution of the river thereby, if the effluent from the sedimentation tanks shall be discharged directly into the stream.

It is probable that the water used in cooling the rolls will not be seriously polluted and that the volume of the waste to be treated can be very greatly reduced if this water is kept separate from that used in the processes of grinding and washing; and the Board recommends that provision be made whereby the water used in cooling will be kept strictly separate from the other wastes. Since it is probable that the heavier wastes will need further treatment, the works should be so arranged that these wastes can be discharged at purification works upon some of the available land near the factory.

The Board recommends that you secure the assistance of an experienced sanitary engineer to advise as to design and arrangement of the drainage system, the location, size and arrangement of tanks and sludge beds, and as to a plan for the treatment and purification of the wastes to prevent objectionable pollution of the Neponset River.

DANVERS (CREESE & COOK COMPANY).

To the Board of Health of the Town of Danvers. JULY 7, 1910.

GENTLEMEN: — The State Board of Health received from you on May 25, 1910, the following communication requesting its advice relative to the disposal of wastes from the Creese & Cook tannery: —

> Messrs. Creese & Cook Company and the Keith Leather Company are investigating settling tanks with a view of installing some such arrangements at leather working establishments of theirs in this town. Creese & Cook are much interested in the tanks now in use at the Armstrong Leather Company in Peabody, and have requested this board to inform them as to whether an arrangement of this nature would be acceptable to the State Board. We have inspected these tanks and think favorably of the arrangements with some minor changes to accommodate local conditions. We would like to ask if the State Board would allow the liquid wastes to empty directly into the river after proper treatment in the sedimentation tank or whether they would compel treatment to remove the discolorations.

It appears from an examination of the disposal works at the Armstrong tannery in Peabody that the waste liquids from the various processes first pass through small tanks within the factory and are subsequently discharged into a large settling tank having a capacity of about 15,000 gallons, the effluent from which is discharged into the Peabody sewers. The total quantity of waste discharged from this factory apparently amounts to about 30,000 gallons per day, so that the waste is about five hours in passing through the final settling tank.

The waste discharged from the Creese & Cook tannery is similar in character to that of the Armstrong works, but, so far as can be judged from the quantity of water used, its volume is nearly twice as great; and in order to give the same period of sedimentation the settling tank would need to be twice the size of that at the Armstrong works. Judging from the limited observation that it has been practicable to make of the quantity of solid matter removed from the waste by the tank at the Armstrong works, a properly designed settling tank would be capable of removing about one-third of the organic matter now discharged into the Crane River from the works of Creese & Cook, provided the tanks received proper care. The effluent from such a tank, however, would not only be colored but would still contain a quantity of putrescible organic matter as great as is found in strong domestic sewage, and the use of such a tank alone would not prevent objectionable conditions in the Crane River resulting from the discharge of tannery waste into that stream.

In a communication to your board last year the State Board of Health made the following recommendation: —

> The Board recommends that a careful investigation be made to determine the best practicable plan of collecting and disposing of the sewage of the town, including the waste from tanneries and other establishments which now pollute the streams and waters about it; and at the same time plans for the sedimentation of the wastes from the various establishments should also be prepared, since, whether the manufacturing waste shall be disposed of by itself or in connection with a sewerage system of the town, thorough sedimentation of these wastes before treatment or admission to sewers will be necessary. The practicability of disposing of the tannery wastes separately from the town sewage should also be carefully considered.
>
> The Board advises that these investigations be made under the direction of an engineer of experience in matters relating to the collection, disposal and purification of sewage and manufacturing waste, and the Board will give you such assistance as it can by making the necessary examinations of the manufacturing wastes and will give you further advice in this matter when you have the results of investigations to present.

It will be essential, in the opinion of the Board, to provide proper settling tanks at the Creese & Cook tannery as well as at the other tanneries in connection with any system for the disposal of the manufacturing wastes from this works, but it is very desirable that, before these tanks are constructed, an investigation be made to determine upon a plan for the final disposal of these wastes, whether in connection with the sewage of the town or separately, in order to determine upon the most economical location and elevation for the settling tanks and such other appliances as may be necessary, and the Board advises that the investigation recommended be made without delay.

The tanks should be designed and constructed under the direction of an engineer of experience in matters relating to the disposal of sewage and manufacturing waste, and in connection with the tanks it will be necessary to provide means for removing and disposing of the sludge in such a way as to avoid creating a nuisance.

GREENFIELD.

MARCH 7, 1910.

To the Committee on Sewage Filtration of the Town of Greenfield, Messrs. GEORGE F. MERRILL, *Chairman,* CHARLES J. DAY, THOMAS L. COMSTOCK and FRANK P. ZABRISKIE.

GENTLEMEN: — The State Board of Health received from you on Jan. 29, 1910, an application for advice as to a proposed plan of sewage disposal for the town of Greenfield, accompanied by a report by your engineer, W. S. Johnson, C.E., of Boston, and plans of the proposed disposal works.

The plans provide for collecting the sewage which is now discharged into Green River at many outlets into an intercepting sewer to be laid in the valley of the river from the upper sewer outlet above Shelburne Street to a point near the mouth of the stream, where it is proposed to purify the sewage by intermittent filtration and discharge the effluent into the river. It is further proposed to discharge all of the sewage temporarily into the Green River near its junction with the Deerfield River.

It appears that the sewers of Greenfield are constructed generally upon the combined plan and receive both sewage and rain water, and it is not deemed practicable to divert the entire flow of the sewers from the river, but the plan provides for diverting into the intercepting sewer all of the flow of the tributary sewers in dry weather, allowing a part of the mingled sewage and storm water at times of heavy rain or when snow is melting rapidly to overflow into the river at the present outlets.

The Board has considered the plans and information presented therewith and has caused the locality to be examined by its engineer. Examinations of the Green River, made under the direction of the Board, show that it is very badly polluted in and below the thickly populated portions of Greenfield, and, in the opinion of the Board, it is very important for the protection of the public health that the sewage of the town of Greenfield be removed from the river as soon as practicable and further nuisance therefrom prevented.

The best practicable plan of preventing the further objectionable pollution of the river is to divert the sewage which is the chief cause of the nuisance to some place where it can be purified or diluted sufficiently to make it unobjectionable.

The soil of the low lands near the mouth of the Green River, upon which the sewage can be delivered by gravity, is not suitable for sewage purification, and in order to deliver the sewage upon any available land in this region containing soil suitable for the purpose, it would be necessary to pump all of the sewage to an elevation many feet above the river. It is practicable, however, by using the suitable soil found in the higher lands in this neighborhood to construct filter beds adequate for the purification of the sewage of Greenfield upon the low lands near the mouth of the Green River, as proposed in the plan presented, and this plan appears to present the only available method by which the sewage of Greenfield can be purified within the limits of the town without pumping.

The Board has considered also the plan of discharging the sewage temporarily into the Green River, and is of the opinion that such an outlet may not be objectionable for a time if located within a few hundred feet of the Deerfield River in such a way that the sewage would flow rapidly to the latter stream and become quickly diffused in the current. Conditions in the Deerfield River are such, however, that there is some danger that if the sewage should be discharged into that river or into the Green River near its confluence with the Deerfield, solid matters from the sewage would collect upon the sides and exposed portions of the bottom of the latter stream in dry weather, and decomposing create objectionable conditions. It is probable, however, that if the sewage should be screened so as to remove objectionable matters likely to float and collect upon the banks of the stream, danger of objectionable conditions being created in the immediate future in the Deerfield River below the sewer outlet would be removed. Under the circumstances the Board is of the opinion that it is permissible to discharge the sewage of the town of Greenfield temporarily into the Green River a short distance above its junction with the Deerfield River, after the sewage has been screened to remove matters likely to float down the stream and collect upon its banks. This method of disposal should be regarded, however, as a temporary one, to be superseded by a more efficient method as soon as the conditions shall make it necessary.

The plan of intercepting only the dry weather flow of sewage for treatment at the disposal works at the present time is the best that it is practicable to adopt under existing circumstances. In the experience of nearly all cities and towns situated like Greenfield it has been found to be necessary sooner or later to separate the sewage from the storm water, and separation is especially important where the sewage is likely to require purification, as in this case, before final disposal. A material saving in the future cost of sewerage and sewage disposal can undoubtedly be made by the town of Greenfield by adopting and strictly adhering to the separate system of sewerage, keeping all storm water and ground drainage, so far as practicable, out of the sewers. Storm water unaffected by sewage can be discharged into any convenient water course without objection, and the Board strongly urges the town to adopt the separate system and not only construct all future sewers upon this plan, but revise the existing system, so as to exclude surface water. The work of separation can be done gradually, and if a portion is done each year, the work can be completed within a reasonable time and the cost can be distributed in such a way that the annual outlay required will not be large.

DEC. 13, 1910.

To the Board of Selectmen of the Town of Greenfield.

GENTLEMEN: — The State Board of Health has considered your petition for the approval by the Board, under the provisions of chapter 49, section 1, of the Revised Laws, of the purchase or taking of a certain parcel of land lying south of Petty's Plain Road and west of the Green River in Greenfield, for the purification and disposal of sewage, and on Thursday, Dec. 1, 1910, gave a hearing, as required by law, notice of said hearing having been given by publication in newspapers in the town of Greenfield.

After the hearing, at which no one appeared to oppose the taking of the land in question by said town, the Board, upon consideration, voted to approve the purchase or taking of such portion of the land in question as the board of selectmen of the town of Greenfield designated as being necesssary for the purification and disposal of sewage; such approval to be given in form upon receiving from said board a detailed plan of the necessary area. The land, the taking of which is now herein approved, is shown upon a plan entitled: —

Town of Greenfield. Office of Board of Selectmen. Plan showing Location of Land of First Congregational Society of Deerfield proposed to be taken by the Town of Greenfield for Purification and Disposal of Sewage under Section 1, Chapter 49 of the Revised Laws. December 1, 1910. Scale — 1″ = 100′.

(Signed) ROBERT E. PRAY, WILLIAM A. DAVENPORT, FRANK GERRETT, } *Board of Selectmen.*

It has an area of 1.7 acres more or less, and is bounded, measured and described as follows: —

Beginning at a point at the northwesterly corner of said tract, which point is on the west boundary line of the land of the First Congregational Society of Deerfield five hundred and sixty-five feet (565) southerly of the intersection of said west boundary and the south side of the County highway known as Petty's Plain Road; Thence southerly on the same line seven hundred and seventy feet (770), more or less, to the Green River; Thence easterly one hundred and ten feet (110), more or less, along the Green River; Thence northerly parallel to the first described line, and one hundred feet (100) distant from the same, seven hundred and fifteen feet (715), more or less; Thence westerly one hundred feet (100) to the place of beginning, the interior angles at the last point and point of beginning being 90° 00′.

HINSDALE.

MAY 19, 1910.

To Mr. G. T. PLUNKETT, *Chairman Water Commissioners, Hinsdale Fire District, Hinsdale, Mass.*

DEAR SIR: — The State Board of Health received from you on April 26, 1910, the following application relative to proposed sewers in the village of Hinsdale: —

> The Hinsdale Fire District proposes to lay down a sewer on its Main Street preparatory to macadamizing the street. The sewer will discharge at either end into the mill pond. The woolen mill connected with the pond is not in operation and has not been for a number of years.
>
> After flowing over the dam there is a rapid fall for several miles towards Dalton. On the street to be sewered there are but 25 families and stores and practically all are now sewered by private drains into the same mill pond. In fact, the whole village is also. While we do not think the matter is of enough importance to demand an investigation on part of your Board we do not feel like going on without first laying it before you.

The Board has caused the locality to be examined by one of its engineers and has considered your application and the information furnished as to the location of the proposed sewers and the conditions affecting the discharge of sewage into the river in the village.

Of the new sewers, it appears that one is to be laid in Main Street from Plunkett Street southerly to the river and is to intercept the flow from an old drain in Plunkett Street which now has an objectionable outlet into the stream. Another sewer will begin at a point on Main Street just north of the hotel and extend northerly through Main Street to the river; while a third, beginning in Main Street in the neighborhood of the hotel, will extend southerly and easterly through Main and Maple streets to the river, — the latter outlet being about 500 feet upstream from the Main Street outlet.

The Board is informed that the proposed sewers are to receive the sewage now being discharged from the hotel, nine dwelling houses and seven other buildings used partly for business and partly as dwellings, and that at some time in the future sewage from about forty houses in the vicinity of Water, Church and Goodrich streets not now provided with sewers will be discharged through these outlets. The total population which will be connected with the sewers now proposed is estimated at 100, and if the sewers should be extended to serve the district indicated the population discharging sewage into the stream would probably amount to 300. A considerable quantity of manufacturing waste is discharged into the river at times. It is understood that storm water is not to be admitted to the sewers.

In the opinion of the Board it is unlikely that the discharge of sewage into the Housatonic River through the two proposed outlets beneath Main Street will create objectionable conditions, provided the outlets are carried into the water in such a way as to be covered with water at all times and avoid fouling the banks of the river. The proposed outlet at Maple Street would discharge into shallow water, and while the quantity of sewage to be discharged there is small, there appears to be no great difficulty in extending the sewer southerly in Main Street to the corner of Maple Street and receiving all of the sewage which would otherwise discharge through the Maple Street outlet, with the exception of that from a house on Maple Street near the river, the sewage of which is already discharged into the stream.

While the discharge of sewage into the Housatonic River at Main Street from the limited population connected with the proposed sewers appears to the Board to be permissible for the present, there is danger that if a larger population than proposed should be connected with these sewers objectionable conditions would result and a nuisance be created in the thickly populated part of the town. There will apparently be no great difficulty, however, in intercepting the sewage which it is proposed to discharge at these outlets and conveying it to some point farther down stream and at a greater distance from the thickly settled portion of the village at any time that it may be necessary, and purifying it there, if necessary, at any time that it may be deemed desirable.

The plan of keeping the storm water separate from the sewage, as you propose, is a very desirable one, and this method should be continued whenever the sewers are extended, since it is not unlikely that it may be found necessary in the future to purify the sewage or remove a part of the organic matter therefrom before it is discharged into the river.

Holden (School Building).

Aug. 1, 1910.

To the School Building Committee, Holden, Mass., Mr. W. J. Powers, *Clerk.*

Gentlemen: — The State Board of Health received from you on June 18, 1910, an application for its approval of a plan of disposing of the sewage from a proposed school building at Holden Center, accompanied by a report describing the proposed works.

The plan provides for conveying the sewage of the school building, which is to contain four rooms, to a rectangular stone cesspool having a capacity of about 5,600 gallons, which is to be located about 125 feet east of the school building. On the easterly slope below the cesspool it is proposed to remove the soil from an area of about 1,000 square feet and replace it with clean gravel for a depth of at least two feet, which is to be covered with loam and seeded. It is expected that the sewage from the cesspool will filter through the gravel and become purified before entering the brook which passes about 50 feet east of the lower limits of the gravel area.

The Board has caused the locality to be examined by one of its engineers and has examined the plans presented. Gravel areas constructed for the disposal of sewage, as proposed in this case, usually become clogged after a longer or shorter period of use, and in order to secure satisfactory results continuously with the plan now proposed it will probably be necessary to remove the filtering material at intervals of a few years, depending upon the quantity of sewage requiring disposal, and replace it with clean gravel. If the works are properly constructed and the filtering material renewed when necessary, unfiltered sewage can be prevented from finding its way into the brook below the area.

With the suggestions contained herein as to the renewal of filtering material when necessary, the Board approves the plan presented.

HYDE PARK (TILESTON & HOLLINGSWORTH COMPANY).

APRIL 7, 1910.

To the Tileston & Hollingsworth Company, Hyde Park, Mass.

GENTLEMEN: — The State Board of Health received from you on March 10, 1910, a report and plans by your engineer for the treatment of the wastes from your mill at Mattapan, which are now discharged into the Neponset River, and has examined the plans and information presented.

The plans now proposed provide in general for discharging all of the machine wastes from the factory (the amount of which, according to the estimates furnished by your engineer some time ago, was between 400,000 and 500,000 gallons per day) into a settling tank having five compartments with an aggregate capacity of 212,000 gallons. It is proposed to pass the machine wastes through three of these compartments, having an aggregate capacity of about 125,000 gallons, and to discharge the effluent therefrom directly into the river. The sediment from this tank is to be discharged upon sludge beds having an aggregate area of 9,148 square feet, which are to be constructed of screened cinders and will have a depth of about 12 inches. The sludge, after drying, is to be removed to some suitable place of disposal.

The washer wastes, which contain large quantities of organic matter and amount to between 250,000 and 400,000 gallons per day and possibly more, are to be discharged into two compartments of the sludge tank, having an aggregate capacity of about 85,000 gallons, the effluent from which will be discharged into the coagulation basin used in connection with the mechanical filters where, after being mixed with river water and coagulation with alum, it will be filtered by the mechanical filters now in use for treating the river water. The wash water from the filters, together with any accumulation of sludge in the coagulating basin, is to be pumped into the compartments of the settling tank used for the washing machine wastes, and the sludge from these tanks is to be discharged upon the sludge beds. It is also proposed, in case the discharge of the machine waste effluent into the river is found to be objectionable, to treat this waste also by mechanical filtration with coagulation.

The Board has examined the plans presented and the information available as to the quantity and character of the waste discharged from this mill, and is of the opinion that, if the character of the machine wastes remains about as shown by recent analyses, these wastes can probably be discharged into the river after sedimentation without creating objectionable conditions there. If, however, this method of disposal should be found to be objectionable, it is probable, in the opinion of the Board, that these wastes can be filtered through the mechanical filters at the mill, and a sufficient quantity of the organic matter removed to render the effluent unobjectionable if discharged into the river.

As to the practicability of treating the washer wastes by mechanical filtration and removing so much of the organic matter that the effluent can be discharged into the river without objection, the Board is unable to advise you definitely with its present information. The analyses of the washer wastes from this mill show that a very large proportion of the solid matter is in suspension, and these matters are of such a character that they can probably be largely removed by sedimentation and filtration at high rates. These washer wastes contain, however, a large amount of nitrogenous organic matter, a large part of which is in solution, and the Board is unable to advise you as to the proportion of this that could be removed by treatment by means of the filters now in use at the factory. It is possible that treatment in this way would give an effluent that would be unobjectionable; if not, however, your experiments upon the treatment of this waste have shown that it could be efficiently purified by the use of sand or cinder filters, which can be located in the neighborhood of the factory.

The settling tanks proposed in your plan now presented appear to be of reasonable size for use in connection with either plan, and the works necessary to attempt the purification of the wastes of the mill by the plan now presented would practically all be available in connection with the works for the purification of the wastes by the plan previously proposed.

Considering the fact that a considerable saving might be made if the wastes from this mill can be efficiently purified by the plan now proposed, and that the works to be provided would practically all be available in case more efficient purification was necessary, the Board sees no objection to attempting to purify the waste by the plan now proposed. The Board recommends that necessary works for the treatment of the wastes according to this plan be constructed at once, in order that the river may be relieved of serious pollution from this mill as soon as possible.

LEOMINSTER.

APRIL 7, 1910.

To F. E. KINSMAN *and others, North Leominster, Mass.*

GENTLEMEN: — The State Board of Health received from you on March 14, 1910, the following petition for an investigation of the conditions likely to prevail in the northerly part of Leominster, as a result of the location of the Fitchburg sewage filter beds in the southeasterly part of the city of Fitchburg: —

> We, the undersigned residents and property owners of North Leominster, situated on the east bank of the north branch of the Nashua River, petition your Honorable Body to investigate conditions likely to prevail there as a result of the location of the proposed Fitchburg sewer beds in the southeast part of Fitchburg adjacent to the residential territory above referred to, with a view of recommending legislation or action as may be deemed advisable and necessary to protect us and our property from the effects of such location of said sewer beds.
>
> The object being, if possible, to bring about the co-operation of Leominster and Fitchburg in the establishment of sewerage disposal beds further down the Nashua River, in a less objectionable locality, by the use of a trunk line sewer through and beyond North Leominster.

In response to this petition the Board has caused the locality to be examined by one of its engineers and has considered the probable extent to which the presence of the filter beds at the location proposed would be noticeable at the dwelling houses of the petitioners.

The proposed filter beds are to be located chiefly in the southeasterly part of Fitchburg, adjacent to the Leominster boundary, and include a small area of land in the extreme southwesterly part of the town of Lunenburg south of the Fitchburg railroad and adjacent to the boundary line between Lunenburg and Leominster.

A careful examination of the locality shows that the nearest dwelling house of any of the petitioners is located at a distance of more than a mile from the proposed sewage disposal works, and that many of them are at distances of more than a mile and a half. In the opinion of the Board, it is improbable that offensive odors or other objectionable conditions likely to affect the health or comfort of your petitioners will be noticeable in the neighborhood of their dwelling houses at any time from properly operated sewage disposal works at the place at which the city of Fitchburg is authorized to construct them.

MANSFIELD.

JULY 7, 1910.

To the Committee on Sewerage of the Town of Mansfield, MR. WALTER M. LOWNEY, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on March 29, 1910, an application for advice as to a proposed system of sewerage and sewage disposal for the town of Mansfield, accompanied by plans and a report by your engineer describing the proposed works. The plan presented provides for collecting the sewage of the thickly populated portions of the town in the valley of the Rumford River in a system of pipe sewers and conveying it to an area of low land near the river, just below Fisher's Millpond, where it is proposed to purify it by intermittent filtration and discharge the effluent into the river.

The sewers are designed to remove the domestic sewage and such manufacturing wastes as may require disposal in connection with the sewage and can properly be admitted to the sewers; but all surface water and, so far as practicable, all ground drainage are to be excluded from the system.

The Board has caused the locality to be examined by its engineer and has considered the plans presented. It is proposed to construct the filter beds below Fisher's Millpond at the site of a cranberry bog on the easterly side of the river, using for the purpose soil taken from the adjacent highlands east of the cranberry bog, where there appears to be an ample quantity of sand well suited for the purpose. The plans provide for the construction there of 30 filter beds having an aggregate area of 12 acres, half of which are to be prepared in the beginning.

Further investigations show that it is practicable, by slight modifications in the outfall sewer, to discharge the sewage by gravity upon land on the westerly side of the river, and a limited number of examinations of the soil in this region show that, while it is quite variable in character, it is probable that suitable filter beds can be constructed there for the disposal of all of the sewage of the town. The region west of the river below Fisher's Millpond is uninhabited, and filter beds located there would be at a much greater distance from dwelling houses than if located on the cranberry bog east of the river.

Considering the circumstances, the Board recommends that the filter beds be located west of the river below Fisher's Millpond at a sufficient distance from the river (100 feet or more) to allow for the maintenance of a growth of trees between the filter beds and the river.

The sewerage system, as shown on the plans presented, is capable of receiving the sewage of all of the thickly settled portions of the town which appear to be in need of sewerage facilities at the present time. There appear to be no large quantities of manufacturing wastes requiring disposal in connection with the sewerage system, and the sizes of the sewers as designed are sufficient for all reasonable requirements. It appears to the Board possible that, by constructing the main sewer in the valley of the river instead of through the main street of the town, the work can be done with less inconvenience and possibly at less cost than by the plans proposed, and before the construction of the system is begun the Board recommends that this question be given further careful consideration.

With the modifications suggested the plans appear to the Board to provide satisfactorily for the collection of the sewage of all of the portions of the town which seem likely to require sewerage for a long time in the future, and the disposal of the sewage by intermittent filtration west of the river below Fisher's Millpond appears to the Board to be the best method that it is practicable to adopt.

MARLBOROUGH.

JULY 21, 1910.

To Hon. JOHN J. SHAUGHNESSY, *Mayor of the City of Marlborough, Mass.*

DEAR SIR: — The State Board of Health received from you on July 6, 1910, through your engineers, Messrs. Metcalf & Eddy of Boston, the following communication describing the proposed plans for improving the sewage purification works of the city of Marlborough and submitting plans of proposed additional filter beds for the approval of the Board under the provisions of Chapter 626 of the Acts of the year 1910: —

Upon petition of Hon. John J. Shaughnessy, mayor of the city of Marlborough, an Act, Chapter 626 of Laws 1910, was passed by the General Court, authorizing the city of Marlborough to issue bonds to the extent of $50,000, for the purpose of constructing additional filter beds and improving the sewage purification works.

The city of Marlborough has authorized us to prepare plans for the contemplated improvements, and in accordance with the stipulations of Section 2, Chapter 626, above referred to, we submit herewith for your approval plans and methods contemplated for the improvements proposed. The time which has elapsed since we were authorized to proceed with this work, has not been sufficient for preparing detailed plans and we submit this statement and outline sketch for your approval, at an early meeting, so that the work of construction may go forward promptly. As soon, — within a very few weeks, — as preliminary plans are prepared, we shall submit them to you for filing, and shall also furnish you with record plans of work actually constructed, upon its completion.

The work contemplated at the disposal area, is the construction of a tank for the purpose of removing a large proportion of suspended solids from the sewage, before its application to the filters, and of applying the sewage to the filters in doses, instead of allowing it to flow continuously onto the beds, as is necessary under the present arrangement. In addition, it is intended to provide between six and seven acres of new filters, located substantially as shown by the dotted lines upon the accompanying plan.

We have made a very careful examination of the territory surrounding the present plant, in hopes of finding more suitable sand than is available upon the lands owned by the city. This search has been fruitless, however, and we have been compelled finally to decide upon constructing more filters upon land now owned by the city.

The effective size of the sand in the proposed beds will vary from 0.07 to 0.2 millimeter, but will probably average between 0.08 and 0.1 millimeter. We realize that this material is extremely fine, but under the circumstances have advised the city to construct the filters shown upon the plan.

If you desire further information regarding the proposed work, we shall be pleased to furnish it as quickly as possible. Should this preliminary statement and sketch show with sufficient clearness the proposed improvements to the sewage purification plant, it would facilitate construction if your Board would formally approve of the course herein outlined.

Further information has also been submitted by the engineers, including a summary of the improvements recommended, together with an estimate of the cost of the work. It appears that there are now 13.68 acres of actual filtering surface in use at the Marlborough sewage disposal area in addition to 2.68 acres usually devoted to the disposal of sludge. The proposed additional area will bring the total filtering surface up to 20.68 acres, or 23.29 acres including the sludge beds. The recommendations of the engineers are summarized as follows: —

1. Rebuild all underdrains not relaid last year.
2. Build tank for sedimentation and dosing.
3. Rebuild certain leaky sewers.
4. Construct seven acres of new filters.
5. Re-arrange certain distribution pipes.

The Board has carefully examined the plans and information presented and has considered the results of the examination of the condition of the filters and the stream below the works. Observations of the flow of sewage in the Marlborough sewers show enormous variation, the maximum amount probably reaching the neighborhood of 3,000,000 gallons per day, while in dry months the average is considerably less than 300,000 gallons per day. During recent years a part of the sewage at times of maximum flow has been diverted to the filters built by the Metropolitan Water Board, and the maximum quantity of sewage reaching the filtration area probably rarely exceeds 2,300,000 gallons per day. In wet periods the quantity of sewage delivered at the filter beds has amounted to as much as 1,250,000 gallons per day continuously for a period of at least three months, and in a year of average rainfall the average quantity of sewage delivered at the filter beds has amounted to as much as 800,000 gallons per day. During the past two years, which have been dry ones, the flow of sewage has been less than usual on account of the reduction in the quantity of leakage and all of the sewage has been passed through the filters.

An examination of the filter beds shows that the material of which they are composed is probably stratified to such an extent as to interfere considerably with their efficiency, and it appears that the condition of the underdrainage in the filters which have been examined has been found to be unsatisfactory. The sand of which the filters are constructed is quite fine, but this material is capable of purifying sewage very effectively if the quantities of sewage applied are limited to its capacity.

Measurements of the quantity of sewage discharged at the filtration area show that in the wetter portion of a year of average rainfall, it is evidently necessary to apply sewage to the filters at a rate of as much as 100,000 gallons per acre per day for periods of several months, and sometimes in larger quantities. Such rates are far in excess of the capacity of filters of such fine material for the satisfactory purification of sewage even if the filters were well constructed and operated most efficiently. The addition of seven acres of new filters as proposed will increase the capacity of the works, but the material of which these filters are to be composed is so fine that their capacity is limited and the quantity of sewage delivered at the filter beds in the wetter portion of the year, especially in years of more than average rainfall, will necessitate the application of sewage to the filters at much higher rates than they are capable of purifying efficiently. While there has been an improvement in the character of the effluent of the filter beds during the present year, a result due in part no doubt to the enlargement and improvement in the filters made last year, the improvement is no doubt aided very materially by the reduction in the flow of sewage due to the continued low rainfall.

The investigations of your engineer show not only that a very large quantity of ground water finds its way into the sewers, but that they also receive large quantities of surface water at times of rain and when snow is melting. Surface water enters the sewers through perforated manhole covers, especially those located in low places, and through the brickwork of manholes, some of which are out of repair. It is probable, also, that considerable quantities of surface water enter the sewers through direct connections from roofs and cellars.

The entrance of surface water through perforated manhole covers can readily be prevented by substituting tight covers, as recommended by your engineer, and raising and repairing manholes would also tend to exclude considerable quantities of surface water. These improvements could be made at small expense. It is also practicable by thorough inspection to locate connections through which surface water is admitted to the sewers from roofs and cellars, and these connections can be cut off, though it may be necessary in some cases to provide surface water drains for the purpose.

It further appears that large quantities of surface and ground water enter the sewers through drains in the neighborhood of the New York, New Haven & Hartford Railroad property, which could be apparently diverted without serious difficulty. While the investigations of your engineer show that ground water leaks into the sewerage system pretty generally throughout the city, there are certain sections in which the leakage into the sewers is much greater than in others, and that by rebuilding sewers having an aggregate length of about a mile in different places it would be practicable to relieve the system of large quantities of ground water and thus reduce materially the flow in the sewers.

While it is impracticable, from the information available, to determine definitely to what extent the flow of sewage would be reduced by carrying out these suggestions, it appears to the Board essential either that the quantity of sewage discharged at the filtration area be materially reduced or that the capacity of the filtration area be enlarged in order that the sewage may be purified at all times to such a degree that it can be discharged into the brook below the filter beds without being deleterious to the public health.

The Board approves the plan of constructing immediately seven acres of new filters as proposed, and approves also the recommendations of your engineer as to the building of suitable sedimentation and dosing tanks, and as soon as practicable thereafter the rebuilding of all underdrains not relaid last year, and would add the breaking up of stratification in the upper 12 inches of these beds.

If, in addition to these improvements, the further recommendations of your engineer relative to rebuilding leaky sewers is carried out, including the repairing of manholes, replacing perforated with tight manhole covers, the cutting off of surface drains and the exclusion of roof water and cellar drainage, it is probable that the enlarged filtration works will then purify the remaining sewage so that the effluent will be unobjectionable. The sufficiency of these improvements will depend upon the extent to which storm water now entering directly or through the ground is excluded. If a large part of this water be not excluded it will be necessary to still further enlarge materially the filtration area.

SEPT. 7, 1910.

To the Board of Sewer Commissioners of the City of Marlborough.

GENTLEMEN: — The State Board of Health received from you on Aug. 30, 1910, through your engineers, Messrs. Metcalf & Eddy, a plan showing outlines of a proposed settling tank to be used in connection with the sewage disposal system of the city, accompanied by a communication from your engineers relative thereto.

The plan provides for a settling tank in two compartments having an aggregate capacity of about 275,000 gallons, and a dosing tank having a capacity of 35,500 gallons. The details of the operation of the tank and the removal of sludge are not presented, but the capacity of the tank appears to the Board to make reasonable provision for the sedimentation of the sewage before its application to the filter beds.

NEW BEDFORD.

DEC. 14, 1910.

To the Hon. CHARLES S. ASHLEY, *Mayor of the City of New Bedford.*

DEAR SIR: — The State Board of Health received on Aug. 4, 1910, the following application in the form of an order from the board of aldermen for advice relative to a proposed system of sewage disposal for the city of New Bedford, with an outlet in Buzzard's Bay: —

> *Ordered,* That the plan prepared by the city engineer showing a proposed location in Buzzard's Bay of the outfall pipes of the intercepting sewer system and the location of the screen chambers, power house, and sand catcher at the southerly end of West French Avenue on Clark's Point in this city, be submitted to the State Board of Health for their advice in accordance with section 117 of chapter 75 of the Revised Laws.

The application was accompanied by plans giving a general outline of the proposed works. Subsequently a further communication was received from the city engineer, Mr. William F. Williams, stating that the advice of the Board was especially desired at this time upon the proposed outlet for the sewage, leaving all matters pertaining to the intercepting sewer for consideration at some later period. Your engineer has also submitted in connection with the application and plans the results of a large number of experiments and observations made to determine the movement and velocity of the tides and currents in portions of Buzzard's Bay adjacent to the city, together with information as to the character of the bottom, direction of prevailing winds, etc.

After an examination of the plans and information presented and conferences with your engineer, at the suggestion of the Committee on Water Supply and Sewerage of this Board the location of the outlet was changed by carrying it somewhat farther east than at first proposed, to a point 3,600 feet southeast of the location of the old tower on Clark's Point, at a place where the depth of water is about 27 feet at low tide, the location of the proposed outlet, as finally presented, being shown upon a plan submitted on Oct. 10, 1910, entitled "Plan, Profile and Details of Outfall, Screens and Sand Catcher. Intercepting Sewer. New Bedford, Mass. William F. Williams, City Engineer. Oct. 10, 1910."

The plan provides that the sewage on its way to the outlet shall be passed through screens for the removal of matters likely to float upon the water, and through a sand-catcher for the removal by sedimentation of such heavy matters as might deposit upon the bottom of the sea in the neighborhood of the outlet.

On Dec. 1, 1910, the Board gave a hearing upon the location selected for the discharge of the sewage of the city of New Bedford to all persons interested therein, notice of the hearing being given by publication in newspapers in the city of New Bedford.

After the hearing and further consideration of the plans presented, the Board voted to approve the location of the proposed outlet in Buzzard's Bay for the disposal of the sewage of the city of New Bedford, after screening and the removal of heavier matters by means of a sand-catcher, as proposed, the outlet to be located at the point shown upon the plan filed with this Board on Oct. 10, 1910, and described herein.

It is understood that detailed plans of the proposed intercepting sewer or sewers and appurtenances will be presented for the consideration of the Board at a later time.

NORTHAMPTON.

AUG. 4, 1910.

To the Board of Sewer Commissioners of the City of Northampton, Mass.

GENTLEMEN: — The State Board of Health received from you on May 9, 1910, a petition requesting permission to continue until otherwise ordered the present method of disposal of the sewage of the city of Northampton by discharging it into the Mill River at a point 1,200 feet below Meadow Street, the period within which the present method of disposal is authorized expiring on Dec. 1, 1910.

In response to this petition the Board has caused the locality to be examined by its engineer and has carefully considered the information presented and the results of the examinations of the Mill River and the sewage disposal system of the city made from time to time since 1905.

It appears that in accordance with the suggestion of the Board in 1905 the channel of Mill River has been cleaned and kept free from obstructions, that a large part of the storm water has been diverted from the sewers and much progress made in the separation of the sewage from the storm water in the portions of the city served by the combined system of sewers. Analyses of the water of the river at various points along its course have shown that there has been a reduction in the quantity of pollution entering the river in the thickly settled portions of the city and an improvement in its appearance and condition.

After consideration, the Board voted that if the separation of sewage from the storm water be carried to completion as rapidly as practicable, thus more completely removing the pollution of the river by sewage and manufacturing wastes in the thickly populated portions and reducing the amount of sewage to be conveyed to the Connecticut River, the Board will extend the time for the completion of the main sewer to the Connecticut River to Dec. 1, 1915, unless the Board finds it necessary to require the removal of sewage from Mill River previous to that date.

NORTH READING (NORTH READING STATE SANATORIUM).

DEC. 1, 1910.

To Dr. ERNEST B. EMERSON, *Superintendent, North Reading State Sanatorium, North Reading, Mass.*

DEAR SIR: — The State Board of Health has considered your application for advice as to the proposed system of sewage disposal for the North Reading State Sanatorium and the plans for the proposed works submitted therewith.

It appears at the present time that the sewage is conveyed through a 6-inch main sewer to a cesspool located southeast of the buildings from which it overflows to another cesspool and is thence discharged into a number of ditches extending in various directions. These ditches are offensive, and it is now proposed to discontinue their use and dispose of the sewage on filter beds.

The plans submitted provide for constructing a sewer, 8 inches in diameter, from the second cesspool, a distance of 35 feet, to a dosing tank having a capacity of about 5,000 gallons, whence the sewage will flow a distance of about 300 feet to the filter beds.

The filter beds shown on the plan are 15 in number and have an aggregate area of a little over 0.9 of an acre. They are to be constructed with underdrains 26 feet apart connected with a main underdrain through which the effluent will be discharged upon the ground below the filtration area.

The Board has caused the locality to be examined by its engineer and has examined the plans presented.

The sand available for the construction of the filter beds is very well adapted for the purpose, and the area of filters which it is proposed to construct is sufficient for the requirements of the institution at the present time. If the beds are properly constructed and operated they will, in the opinion of the Board, be capable of purifying the sewage of the institution satisfactorily at all times.

When the beds are completed the use of both cesspools should be discontinued, as the effect of their use may be unfavorable to the efficiency of the filter beds in the purification of the sewage.

SHIRLEY (F. D. WEEKS EXTRACTING COMPANY).

MAY 19, 1910.

To the F. D. Weeks Extracting Company, Shirley, Mass.

GENTLEMEN: — The State Board of Health received from you on April 29, 1910, a communication stating that you desire to enlarge your works at Shirley to include a plant for the scouring and carbonizing of wool and noils, and requesting to be advised whether by putting in settling beds of earth for the purpose of settling out the grease and soap it would be permissible to discharge the remainder of the manufacturing waste into the stream; and in response to this request the Board has caused the locality to be examined by one of its engineers and has considered the information presented.

It appears that it is proposed to scour from 8,000 to 10,000 pounds of wool per day at a mill south of and adjacent to the Fitchburg Railroad just above Shirley Village, and to discharge the refuse which would amount to perhaps 15,000 to 20,000 gallons per day through settling tanks into Catacoonamug Brook. The area of the watershed of this brook above the mill at which it is proposed to scour the wool is about 20 square miles, and the flow of the stream is probably well maintained during dry weather by the large amount of storage contained in the Shirley Reservoir and other ponds; but there is no doubt, in the opinion of the Board, that with the best designed settling tanks the waste from the scouring of 8,000 to 10,000 pounds of wool per day would create a nuisance in the brook which flows through the village of Shirley a short distance below the mill. It is, furthermore, very doubtful, in the opinion of the Board, whether it would be practicable within the limited area of ground which appears to be available in the neighborhood of the factory to purify the wastes from scouring the quantity of wool indicated to a sufficient extent to prevent a nuisance in the brook.

It might be possible by constructing a grease extracting plant and subsequently treating the wastes for the removal of organic matter to produce an effluent that would not cause a nuisance in the brook, but there does not appear to be a sufficient area of available land in the neighborhood of the mill where works adequate for the proper treatment of these wastes could be constructed. At the upper mill below the outlet of the Shirley Reservoir a much larger space is available for the treatment of such wastes, and there appears also to be a considerable area of land in the neighborhood composed of gravelly soil which might be suitable for the filtration of the wastes after the grease has been extracted, and it is possible that the scouring of 10,000 pounds of wool per day could be carried on at the upper mill if a grease extracting plant and suitable works for the subsequent purification of the wastes should be installed there without creating a nuisance in the brook. This is very doubtful, however, and the Board recommends that before installing any works or machinery for the treatment or scouring of the wool at any point in the valley of this brook you secure the advice of an expert in the matter of purification and disposal of such wastes to prepare a plan which will provide for their treatment in such a way that they will not be likely to cause a nuisance in the brook.

If you decide to proceed further in this matter and engage an expert to design a method for the treatment of the wastes mentioned in your communication the Board will give you such information as has been collected concerning the method of disposing of such wastes, and will give you further advice when you have a plan for the treatment of the wastes to present.

STOUGHTON.

FEB. 3, 1910.

To the Committee on Sewerage of the Town of Stoughton.

GENTLEMEN: — The State Board of Health received from you on Jan. 31, 1910, a request for advice as to a proposed system of sewerage and sewage disposal for the town of Stoughton, accompanied by plans showing the location of the proposed sewers and disposal works.

The plans provide for collecting the sewage of the main village of Stoughton in a system of pipe sewers and conveying it by gravity to a filtration area to be located along the westerly side of the Stoughton Branch of the New York, New Haven & Hartford Railroad and 500 feet or more south of the boundary between the towns of Stoughton and Canton, where it is proposed to purify it by intermittent filtration and to discharge the effluent through a main drain directly into Steep Hill Brook, a tributary of the east branch of the Neponset River. The works are designed to take the manufacturing wastes from all of the factories in the village of Stoughton, but it is not practicable to receive into the sewage disposal system by gravity the manufacturing wastes from the mills in West Stoughton, though it appears that these wastes and the sewage of that village can be discharged into the general system by pumping without great difficulty or expense.

The Board has caused the locality to be examined by its engineer and has carefully examined the plans presented. The area which it is proposed to use for the disposal of the sewage is well located for the purpose, and an examination of test pits in various portions of it shows that it contains an ample quantity of soil of excellent quality for the purification of sewage by intermittent filtration. In the opinion of the Board, the sewage of the town can be efficiently purified at the proposed filtration area so that the effluent can be discharged into Steep Hill Brook, as proposed, without creating objectionable conditions in that stream or in the neighborhood of the disposal works.

The capacity of the proposed main sewers is ample for the requirements of the town and reasonable allowance is made for future requirements. It is of the greatest importance, in the opinion of the Board, that care be taken to exclude all surface water and ground drainage so fas as practicable from the sewerage system, as recommended by your engineer, since, if surface water or ground drainage in considerable quantity should be allowed to enter the sewers, the operation of the sewers and disposal works is likely to be seriously interfered with and the cost of maintaining the system and purifying the sewage will be greatly increased.

The area of the filter beds which it is proposed to construct in the beginning, amounting to about 7 acres, is a reasonable one under the circumstances, and the construction of a settling tank is in this case unnecessary. Filter beds of the size proposed properly underdrained, as provided in the plans submitted, are likely to be adequate for the requirements of the town until there is a material increase of the population, provided the sewers are properly constructed.

In the opinion of the Board, the plan presented is an appropriate and satisfactory one for the collection and disposal of the sewage of the town of Stoughton. It makes provision for the disposal of the wastes from all of the manufacturing establishments in the main village by gravity, and whenever it is deemed necessary or desirable in the future the sewage or manufacturing wastes from West Stoughton can be disposed of in connection with the proposed works.

The Board recommends that the main sewer and filtration works and such portion of the tributary sewers in the village as may be necessary to remove all sources of pollution from the streams and drains, be constructed without delay, since it is evident from the examinations made by the Board that considerable pollution from factories, dwelling houses and the drains of the town is finding its way into one of the tributaries of the Neponset River in Stoughton, contrary to the provisions of chapter 360 of the Acts of the year 1906.

The construction at once of a system of sewers and sewage disposal for the town will be likely to save the town much inconvenience and expense from the enforcement of the law relative to preventing the pollution of the Neponset River.

TAUNTON.

SEPT. 7, 1910.

To the Board of Sewer Commissioners of the City of Taunton.

GENTLEMEN: — The State Board of Health has considered your application of July 24, 1910, for the extension of time for the completion of the works for purifying the sewage of the city of Taunton, which is now being discharged temporarily into the Taunton River near the electric light station below Weir Bridge, and on Aug. 4, 1910, gave a public hearing to the petitioners and other persons interested, including representatives of the towns along the river below the city.

The Board, having considered the information presented and having examined the locality and the results of numerous analyses of the water of the main stream and its tributaries at various points both above and below the city, voted at its meeting on Sept. 1, 1910, that the time for completing the sewage disposal system of the city of Taunton be extended as follows: that one year be allowed from Dec. 1, 1910, for the more complete removal of sewage from Mill River after the sewage of the Taunton Insane Hospital is removed, for the further study of the most efficient and economical method of sewage disposal by expert engineers, for approval by the State Board of Health and for the making of working plans for construction; that thereafter the work of construction be prosecuted with reasonable dispatch and completed within three years after Dec. 1, 1910.

WALPOLE (S. GRAY COMPANY).

AUG. 4, 1910.

To the S. Gray Company, Walpole, Mass., MR. JOSEPH S. LEACH, *Superintendent.*

GENTLEMEN: — The State Board of Health received from you on July 29, 1910, a plan and report by your engineer, Mr. E. Worthington, C.E., of Dedham, in regard to the disposal of the manufacturing wastes which are now discharged into the Neponset River from your mill. The proposed disposal works as described in the report and shown upon the plan provide for the construction of a settling tank having a capacity of approximately 40,000 gallons and three filter beds, each 3 feet in depth and having an aggregate area of 18,785 square feet, or 0.43 of an acre, to be constructed of sand or cinders in the rear of the factory close to the bank of the river. Provision is made for the construction of an additional settling tank and for a future extension of the filter beds which would bring the total area of the filters up to about 0.7 of an acre. Your engineer estimates that the total volume of wastes requiring treatment is about 35,000 gallons per day, which does not appear to include wastes which come from time to time from the mercerizing department. With the quantity of wastes estimated, 35,000 gallons per day, the rate of filtration upon the filter beds proposed for construction in the beginning would be a little over 80,000 gallons per acre per day, and at times when the waste is being discharged from the mercerizing process the rate of filtration would be greater than the amount stated. If the entire filtration area shown upon the plan should be constructed the rate of filtration would be about 50,000 gallons per acre per day.

The Board has carefully considered the plans submitted and the results of numerous analyses of the wastes from this mill and of experiments upon their purification made at the experiment station of the Board at Lawrence. The results of these tests show that the waste from this mill can probably be purified satisfactorily by means of sand filters 3 feet in depth, if the filters are properly operated, at a rate not exceeding about 50,000 gallons per acre per day.

Under the circumstances the Board is of the opinion that if the quantity of foul waste discharged from this mill is not greater than estimated by your engineer these wastes can be purified satisfactorily by the proposed plan, if all of the filters shown upon the plan submitted shall be constructed in the beginning. If the quantity of wastes discharged from the mercerizing department is considerable, it is probable that a larger area will be required. The Board advises that a careful measurement be made of all the wastes from the mill, and that a sufficient area of filter beds be built of the general design of those shown upon the plan, that the rate of filtration may not exceed 50,000 gallons per acre per day.

WESTBOROUGH (HICKEY-RIEDEMAN COMPANY).

MARCH 16, 1910.

To the Hickey-Riedeman Yeast Company, Westborough, Mass.

GENTLEMEN: — A further examination of the liquid wastes discharged from your works into the sewers of the town of Westborough show that these wastes still contain alcohol and yeast, and that they are not discharged in such a way as to distribute the flow evenly throughout the twenty-four hours of the day.

You are hereby notified that unless the requirements of the order of the Board of Nov. 4, 1909, are complied with, this matter will be referred to the Attorney-General for action under the provisions of chapter 433 of the Acts of the year 1909.

APRIL 13, 1910.

To the Hickey-Riedeman Company, Westborough, Mass.

GENTLEMEN: — The State Board of Health is satisfied after investigation that the unsatisfactory operation of the sewage disposal system of the town of Westborough is due wholly or partly to the discharge into such sewerage system of liquid wastes from your yeast factory in Westborough containing alcohol and yeast, which are substances of such a character as to interfere with the efficient operation of said works; and the Board, acting under the provisions of chapter 433 of the Acts of the year 1909, hereby requires the treatment of all of the wastes from the processes of making yeast at your factory in such manner as will remove the alcohol and yeast therefrom.

WRENTHAM (WRENTHAM STATE SCHOOL).

NOV. 3, 1910.

To the Board of Trustees of the Wrentham State School, DR. GEORGE L. WALLACE, *Superintendent.*

GENTLEMEN: — On Oct. 7, 1910, the State Board of Health received from you through your engineer plans of a system of sewerage and sewage disposal for the Wrentham State School.

It appears that the total population of the institution at the present time is somewhat less than 300, but that the school is designed for the accommodation, eventually, of about 1,000 patients, and that the total population, including attendants, may amount to 1,250. The plan for disposing of the sewage provides for collecting the sewage from all of the buildings, including the laundry, into a main sewer leading northeasterly from the buildings to filter beds to be located on the easterly side of North Street in Wrentham, not far from the Norfolk boundary, where it is proposed to purify the sewage by intermittent filtration and discharge the effluent into a small stream tributary to the Charles River. A dosing tank, having a capacity of about 7,700 gallons, is to be located on the line of the main sewer about 1,800 feet from the filtration area. The filtration area is divided into 16 beds, each about 75 feet square, having an aggregate area of about 2 acres, half of which it is proposed to construct in the beginning.

The Board has caused the locality to be examined by one of its engineers and has considered the plan presented, and concludes that the works in general, if properly constructed and maintained, will provide adequately for the disposal of the sewage of the institution for the present time.

No measurements of the quantity of sewage now discharged from the institution are available, but judging from the quantity of water used, some of which is used for irrigation, the quantity of sewage may amount to as much as 30,000 gallons per day. Filter beds aggregating an acre in area would be ample for the purification of this quantity of sewage, but if the population at the school is to be increased in the near future, it will be best to construct the entire area of filter beds shown on the plan in the beginning.

It is essential, in order to secure the best results in the operation of the filter beds, that the works be constructed under careful engineering supervision and that this supervision be continued for a time in the operation of the filter beds. The filter beds are located at no great distance from a public highway, and it is especially important that a growth of trees be maintained about the filter beds and especially between them and the road. By observing these recommendations, the filter beds can be so constructed and operated that they are likely to purify the sewage satisfactorily without causing objection in the neighborhood, either by objectionable odors or the pollution of adjacent waters.

MISCELLANEOUS.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to miscellaneous matters: —

DANVERS.

To the Board of Health of the Town of Danvers. JAN. 6, 1910.

GENTLEMEN: — The State Board of Health has considered your application of Nov. 23, 1909, for an examination of Crane River and advice as to improving the conditions there, and has caused the locality to be examined by its engineer and samples of the refuse discharged into the stream to be analyzed.

Crane River is a tidal estuary which drains a small fresh water watershed. It is polluted near its upper end by the manufacturing wastes from two tanneries, and just below the tide mill near its outlet it is further polluted by the foul drainage from two other tanneries. It probably receives considerable further pollution from the large population on its watershed.

At the time of the recent examination the quantity of polluting matter discharged from the tanneries at the upper end of the stream was less than usual. The stream, however, was still considerably polluted in this region and was very badly polluted below the tide mill. At some of the tanneries there are settling basins and an attempt is made to remove a portion of the solid matter from the wastes before they are discharged into the river, but the works for treating the wastes at these tanneries are inadequate, and, as they do not receive proper care, they remove but little of the putrescible organic matter from the tannery wastes.

The question of the disposal of the wastes from these tanneries, especially those at the upper end of the river, was carefully considered by this Board several years ago, and investigations and experiments were made to determine definitely the character of these tannery wastes and the methods by which they could be purified. The results of these investigations showed that a considerable portion of the putrescible organic matter could be removed from the wastes by properly designed settling tanks, when operated with care, and that the wastes could be efficiently purified, after such sedimentation, by filtration through filters composed of coke, or sand or gravel. These results were communicated to your board, and copies of the advice of the Board at that time are enclosed herewith.

It appears to the Board that the best practicable plan of disposing of the wastes from the tanneries which now pollute Crane River and from other manufacturing establishments discharging their wastes into the waters about the town, would be to collect these wastes in connection with the general system of sewerage to serve the thickly settled portions of the town of Danvers, in which a sewerage system has evidently become necessary.

The only other practicable plan of preventing the nuisance caused by manufacturing wastes discharged into the waters about the town will be to purify them by the methods already suggested, to such a degree that the effluent will not cause objectionable conditions when discharged into such waters. It is impracticable at the present time, with the information available, for the Board to advise you definitely as to whether these wastes can best be purified separately by works at each tannery or whether it will be better to collect the drainage from two or more of these establishments at some point where a purification works can be located in this region.

It is probable that the purification of these wastes to such an extent as to prevent the objectionable pollution of local waters will require further treatment than would be provided for by sedimentation alone, and it is likely under the circumstances that it will be best to collect most of the tannery wastes and dispose of them at a single works. As to the location of such a works, no definite advice can be given, since it is impracticable to make a satisfactory examination of the various localities that may be available at this season of the year. It is probable, however, that a suitable place can be found near the southerly side of Crane River, where works might be located at a sufficient distance from dwelling houses to prevent a nuisance.

There is a further important reason, in the opinion of the Board, why some action should be taken without delay to prevent the further pollution of Crane River and the waters about Danvers by sewage and manufacturing waste. The cities of Salem and Beverly and the town of Peabody have spent large sums of money for the removal of sewage and manufacturing waste from the North River and its tributary streams and estuaries, which also drain the town of Danvers, and, in the opinion of the Board, the value of the work done by those municipalities will be diminished if the town of Danvers is to continue to use Crane River and other streams in the neighborhood increasingly as an outlet for unpurified sewage or objectionable manufacturing wastes, such as are now discharged there.

The Board recommends that a careful investigation be made to determine the best practicable plan of collecting and disposing of the sewage of the town, including the waste from tanneries and other establishments which now pollute the streams and waters about it; and at the same time plans for the sedimentation of the wastes from the various establishments should also be prepared, since, whether the manufacturing waste shall be disposed of by itself or in connection with a sewerage system of the town, thorough sedimentation of these wastes before treatment or admission to sewers will be necessary. The practicability of disposing of the tannery wastes separately from the town sewage should also be carefully considered.

The Board advises that these investigations be made under the direction of an engineer of experience in matters relating to the collection, disposal and purification of sewage and manufacturing waste, and the Board will give you such assistance as it can by making the necessary examinations of the manufacturing wastes and will give you further advice in this matter when you have the results of investigations to present.

SEEKONK.

SEPT. 1, 1910.

To the Board of Health of the Town of Seekonk.

GENTLEMEN: — In response to your communication requesting the advice of the State Board of Health as to the action of your board in the matter of a proposed cemetery to be located near the Ten Mile River in that town, the Board has caused the locality to be examined and has considered the information presented.

It appears that the land is situated about a quarter of a mile from the highway and from any dwelling and approaches within 30 feet of a brook which flows into the Ten Mile River about one and one-half miles from the pumping station of the East Providence Water Company; and that you have approved the use of these lands as a cemetery, restricting the area to be used for burial purposes to that which is situated more than 200 feet from the brook and more than 300 feet from a spring situated very close to the division line between this land and the land owned by the heirs of Lillian Nesbit.

In the opinion of the Board the lands indicated, with the restrictions imposed by your board, may safely be used for the purposes of a cemetery. The Board recommends that a plan and description of the lands approved be filed at this office.

EXAMINATION OF PUBLIC WATER SUPPLIES.

Examination of Public Water Supplies.

The usual chemical analyses of the principal sources of public water supply in the State have been made during the year and are presented in the two following tables, the first of which contains averages of analyses of the surface-water supplies and the second the averages of analyses of the ground-water supplies.

Averages of Chemical Analyses of Surface-water Sources for the Year 1910.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Free.	Albuminoid.			Nitrates.	Nitrites.		
					Total.	Suspended.					
Metropolitan Water District.	Wachusett Reservoir, upper end.	.27	3.27	.0018	.0132	.0019	.25	.0017	.0000	.38	0.9
	Wachusett Reservoir, lower end.	.13	2.99	.0018	.0129	.0017	.25	.0011	.0000	.27	0.9
	Sudbury Reservoir, .	.13	3.15	.0022	.0131	.0021	.27	.0023	.0000	.25	1.1
	Framingham Reservoir No. 3.	.14	3.30	.0026	.0143	.0026	.28	.0026	.0000	.26	1.1
	Hopkinton Reservoir, .	.48	3.99	.0019	.0177	.0018	.37	.0016	.0000	.58	1.2
	Ashland Reservoir, .	.58	3.94	.0023	.0198	.0019	.33	.0013	.0000	.68	1.1
	Framingham Reservoir No. 2.	.67	4.66	.0039	.0237	.0027	.40	.0017	.0000	.77	1.2
	Lake Cochituate, . .	.23	5.90	.0021	.0205	.0041	.61	.0012	.0000	.37	2.2
	Chestnut Hill Reservoir,	.14	3.33	.0024	.0132	.0019	.29	.0027	.0000	.25	1.1
	Weston Reservoir, . .	.12	3.18	.0021	.0126	.0021	.27	.0032	.0000	.25	1.1
	Spot Pond, . . .	.09	3.49	.0015	.0144	.0021	.33	.0004	.0000	.19	1.2
	Tap in State House, .	.14	3.09	.0014	.0118	.0016	.28	.0031	.0000	.23	1.1
	Tap in Revere, . .	.09	3.61	.0010	.0125	.0016	.32	.0007	.0000	.21	1.4
	Tap in Quincy, . .	.13	3.46	.0011	.0098	.0006	.28	.0033	.0000	.22	1.2
Abington, . .	Big Sandy Pond, . .	.11	3.76	.0026	.0164	.0016	.73	.0003	.0000	.15	0.5
	Little Sandy Pond, .	.02	4.15	.0026	.0172	.0035	1.22	.0010	.0000	.17	0.4
Adams, . .	Dry Brook, . . .	.18	6.67	.0021	.0093	.0017	.12	.0067	.0000	.30	4.7
	Bassett Brook, . .	.03	3.98	.0019	.0057	.0009	.12	.0123	.0000	.09	2.3
Amherst, . .	Amethyst Brook Reservoir.	.25	3.18	.0018	.0148	.0038	.17	.0010	.0000	.34	0.7
	Lower Reservoir, . .	.29	3.72	.0026	.0135	.0032	.19	.0020	.0000	.36	0.9
Andover, . .	Haggett's Pond, . .	.12	4.21	.0017	.0158	.0010	.37	.0005	.0000	.28	1.3
Ashfield, . .	Bear Swamp Brook, .	.35	5.82	.0011	.0127	.0017	.08	.0017	.0001	.49	2.8

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.						
				Free.	Total.	Suspended.		Nitrates.	Nitrites.		
Athol, . . .	Phillipston Reservoir, .	.45	3.51	.0076	.0434	.0176	.24	.0083	.0000	.60	0.7
	Buckman Brook Reservoir.	.30	3.70	.0048	.0243	.0071	.18	.0028	.0000	.42	0.7
Barre, . . .	Reservoir, ...	.12	3.54	.0022	.0180	.0034	.18	.0022	.0000	.35	1.2
Blandford, . .	Freeland Brook, . .	.09	4.53	.0081	.0047	.0004	.21	.0093	.0004	.09	2.2
Brockton, . .	Silver Lake, . . .	.12	3.19	.0022	.0123	.0018	.65	.0011	.0000	.22	0.5
Cambridge, . .	Upper Hobbs Brook Reservoir.	.46	6.03	.0040	.0317	.0050	.48	.0043	.0001	.64	2.0
	Lower Hobbs Brook Reservoir.	.15	5.80	.0037	.0278	.0045	.48	.0020	.0001	.36	2.3
	Stony Brook Reservoir, .	.40	6.09	.0028	.0226	.0027	.55	.0083	.0001	.51	2.2
	Fresh Pond, . . .	.23	6.60	.0085	.0261	.0071	.61	.0137	.0004	.41	2.9
Cheshire, . .	Thunder Brook, . .	.06	9.25	.0020	.0064	.0014	.11	.0050	.0000	.05	6.7
	Kitchen Brook, . .	.02	8.05	.0026	.0060	.0008	.09	.0020	.0003	.05	5.3
Chester, . .	Austin Brook, . .	.10	3.75	.0010	.0048	.0000	.11	.0020	.0000	.18	1.8
Chicopee, . .	Morton Brook, . .	.08	3.85	.0006	.0032	.0004	.15	.0010	.0001	.06	0.6
	Cooley Brook, . .	.26	4.15	.0028	.0104	.0022	.14	.0010	.0001	.20	1.0
Concord, . .	Sandy Pond, . . .	.06	5.24	.0012	.0083	.0004	.35	.0072	.0005	.13	2.5
	Nagog Pond, . . .	.06	3.44	.0010	.0123	.0022	.31	.0013	.0000	.15	1.0
Dalton, . .	Egypt Brook Reservoir,	.38	3.82	.0017	.0123	.0015	.10	.0047	.0000	.59	1.0
Danvers, . .	Middleton Pond, . .	.46	4.97	.0018	.0195	.0017	.47	.0010	.0000	.66	1.7
Deerfield, . .	Roaring Brook, . .	.05	7.65	.0008	.0040	.0002	.17	.0180	.0001	.07	4.2
Fall River, . .	North Watuppa Lake, .	.16	4.18	.0024	.0205	.0036	.70	.0006	.0000	.30	1.0
Falmouth, . .	Long Pond, . . .	.02	3.12	.0013	.0116	.0010	1.00	.0003	.0000	.12	0.4
Fitchburg, . .	Meetinghouse Pond, .	.09	2.86	.0025	.0134	.0014	.18	.0012	.0000	.20	1.0
	Scott Reservoir, . .	.19	3.26	.0209	.0235	.0075	.27	.0016	.0001	.28	0.6
	Wachusett Lake, . .	.12	2.80	.0030	.0158	.0024	.18	.0005	.0001	.21	0.7
Gardner, . .	Crystal Lake, . .	.10	5.31	.0038	.0125	.0011	.28	.0030	.0000	.19	2.0
Gloucester, . .	Dike's Brook Reservoir,	.30	4.52	.0025	.0159	.0022	1.09	.0010	.0000	.33	0.4
	Wallace Reservoir, .	.43	5.27	.0026	.0201	.0035	1.32	.0007	.0000	.49	0.5
	Haskell Brook Reservoir,	.65	4.53	.0068	.0145	.0021	1.01	.0018	.0000	.36	0.4
Great Barrington, .	East Mountain Reservoir,	.12	4.97	.0015	.0080	.0021	.12	.0003	.0000	.17	3.1
	Green River, . . .	.03	8.83	.0037	.0068	.0008	.11	.0110	.0001	.10	7.0
Greenfield, . .	Glen Brook Upper Reservoir.	.09	5.98	.0043	.0097	.0035	.16	.0023	.0000	.12	3.2
	Glen Brook Lower Reservoir.	.05	5.40	.0048	.0062	.0009	.15	.0020	.0001	.13	3.0
Hadley, . .	Hart's Brook Reservoir,	.09	4.07	.0019	.0048	.0006	.19	.0002	.0000	.15	2.0

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.						
				Free.	Total.	Suspended.		Nitrates.	Nitrites.		
Hatfield, . .	Running Gutter Brook Reservoir.	.17	4.15	.0020	.0104	.0017	.16	.0133	.0000	.25	1.8
Haverhill, . .	Johnson's Pond, . .	.14	4.63	.0017	.0169	.0019	.44	.0013	.0000	.27	2.1
	Crystal Lake, . .	.18	4.06	.0020	.0160	.0017	.37	.0010	.0000	.37	1.6
	Kenoza Lake, . .	.17	4.35	.0020	.0165	.0019	.42	.0005	.0000	.33	2.0
	Lake Saltonstall, . .	.13	5.60	.0023	.0156	.0015	.54	.0017	.0000	.34	2.6
	Lake Pentucket, . .	.16	4.40	.0012	.0166	.0023	.41	.0007	.0000	.33	2.0
	Millvale Reservoir, .	.62	5.15	.0030	.0207	.0019	.38	.0018	.0000	.74	2.0
Hingham, . .	Accord Pond, . .	.69	4.29	.0022	.0161	.0017	.71	.0008	.0000	.89	0.5
Holden, . .	Muschopauge Lake, .	.08	2.94	.0017	.0109	.0009	.30	.0008	.0000	.16	1.1
Holyoke, . .	Whiting Street Reservoir,	.13	4.56	.0033	.0172	.0020	.22	.0012	.0000	.21	2.4
	Fomer Reservoir, . .	.46	4.25	.0026	.0123	.0012	.15	.0021	.0000	.47	1.5
	Wright and Ashley Pond,	.13	4.71	.0031	.0205	.0028	.19	.0010	.0005	.24	2.5
	High Service Reservoir, .	.13	3.99	.0023	.0222	.0033	.18	.0008	.0000	.30	1.8
Hudson, . .	Gates Pond, . . .	.10	3.08	.0033	.0169	.0026	.25	.0015	.0000	.22	1.2
	Fosgate Brook, . .	.58	5.07	.0043	.0250	.0063	.20	.0140	.0002	.64	1.7
Huntington, . .	Cold Brook Reservoir, .	.16	3.76	.0006	.0048	.0003	.15	.0032	.0000	.23	1.5
Ipswich, . .	Dow's Brook Reservoir,	.20	5.17	.0026	.0176	.0032	.83	.0022	.0000	.32	1.9
Lawrence, . .	Merrimack River, filtered.	.43	–	.0057	.0106	–	.48	.0332	.0003	.41	1.5
Lee, . . .	Codding Brook Upper Reservoir.	.40	3.14	.0099	.0198	.0037	.10	.0062	.0000	.50	0.8
	Codding Brook Lower Reservoir.	.28	4.88	.0028	.0118	.0017	.12	.0038	.0000	.35	2.6
	Basin Pond Brook, .	.63	4.20	.0019	.0164	.0019	.11	.0060	.0000	.72	1.4
Lenox, . . .	Reservoir, . . .	.06	8.45	.0009	.0089	.0023	.13	.0010	.0000	.15	7.0
Leominster, .	Morse Reservoir, . .	.21	2.79	.0039	.0190	.0034	.22	.0018	.0000	.33	0.3
	Haynes Reservoir, .	.30	3.11	.0139	.0337	.0079	.22	.0014	.0001	.40	0.3
	Fall Brook Reservoir, .	.12	2.76	.0028	.0140	.0023	.21	.0007	.0000	.27	0.4
Longmeadow, .	Cooley Brook, . .	.15	5.00	.0022	.0086	.0034	.21	.0140	.0003	.19	3.0
Lynn, . . .	Birch Reservoir, . .	.27	4.82	.0051	.0224	.0039	.67	.0007	.0001	.45	1.7
	Breed's Reservoir, . .	.41	4.70	.0065	.0244	.0044	.70	.0010	.0001	.53	1.6
	Walden Reservoir, . .	.42	5.02	.0055	.0225	.0038	.69	.0015	.0001	.58	1.9
	Hawkes Reservoir, .	.57	6.13	.0048	.0295	.0038	.80	.0012	.0001	.78	2.4
	Saugus River, . .	1.14	8.54	.0057	.0367	.0033	.93	.0005	.0001	1.11	3.9
Manchester, . .	Round Pond, . .	.76	5.59	.0032	.0243	.0036	.99	.0010	.0000	.70	1.2
	Gravel Pond, . .	.12	3.97	.0019	.0126	.0020	.82	.0010	.0000	.24	0.9

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.			Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
					ALBUMINOID.						
				Free.	Total.	Suspended.		Nitrates.	Nitrites.		
Marlborough, .	Lake Williams, . .	.11	4.32	.0024	.0182	.0021	.54	.0022	.0000	.25	1.5
	Millham Brook Reservoir.	.42	4.79	.0062	.0247	.0042	.41	.0037	.0000	.53	1.5
Maynard, . .	White Pond, ...	.08	3.16	.0011	.0109	.0012	.30	.0032	.0000	.18	0.9
Milford, . .	Charles River, filtered, .	.22	3.84	.0011	.0075	-	.37	.0084	.0000	.28	1.1
Montague, . .	Lake Pleasant, . .	.09	2.90	.0041	.0105	.0019	.16	.0020	.0001	.12	0.6
Nantucket, . .	Wannacomet Pond, .	.05	6.76	.0013	.0122	.0029	2.17	.0005	.0000	.13	1.5
New Bedford, .	Little Quittacas Pond, .	.28	4.08	.0022	.0213	.0027	.61	.0000	.0000	.42	1.0
	Great Quittacas Pond, .	.38	4.13	.0020	.0213	.0029	.62	.0000	.0000	.58	0.8
North Adams, .	Notch Brook Reservoir,	.09	6.60	.0016	.0057	.0011	.09	.0010	.0000	.15	5.9
	Broad Brook, . .	.22	4.13	.0013	.0101	.0027	.09	.0087	.0000	.38	2.1
Northampton, .	Middle Reservoir, . .	.26	4.23	.0017	.0114	.0028	.14	.0015	.0000	.35	1.8
	Mountain Street Reservoir.	.11	3.50	.0011	.0094	.0024	.12	.0005	.0000	.22	1.7
	West Brook, . . .	.15	4.51	.0005	.0064	.0021	.13	.0035	.0000	.22	2.0
North Andover, .	Great Pond, . . .	.17	4.42	.0020	.0177	.0023	.42	.0008	.0000	.30	1.6
Northborough, .	Lower Reservoir, . .	.61	4.43	.0012	.0250	.0056	.31	.0020	.0001	.66	1.1
Northbridge, .	Cook Allen Reservoir, .	.33	3.54	.0030	.0178	.0041	.28	.0022	.0000	.46	0.4
North Brookfield, .	Doane Pond, . . .	.49	3.47	.0036	.0263	.0045	.16	.0010	.0000	.45	0.7
	North Pond, . . .	.49	3.55	.0013	.0299	.0099	.16	.0007	.0000	.55	0.6
Norwood, . .	Buckmaster Pond, . .	.12	4.72	.0220	.0163	.0046	.65	.0024	.0001	.17	1.4
Orange, . .	Distributing Reservoir, .	.10	4.43	.0007	.0048	.0008	.13	.0007	.0000	.13	1.1
Palmer, . .	Lower Reservoir, . .	.26	4.01	.0082	.0143	.0028	.17	.0022	.0000	.29	0.8
Peabody, . .	Brown's Pond, . .	.17	4.30	.0021	.0178	.0031	.84	.0050	.0001	.28	1.1
	Spring Pond, . . .	.15	5.62	.0047	.0178	.0038	.75	.0040	.0001	.31	2.3
	Suntaug Lake, . .	.06	4.72	.0022	.0168	.0018	.85	.0018	.0000	.23	2.6
Pittsfield, . .	Ashley Lake, . . .	.31	4.45	.0012	.0110	.0024	.11	.0020	.0000	.46	2.2
	Ashley Brook, . .	.31	5.52	.0018	.0141	.0049	.10	.0080	.0000	.41	3.2
	Hathaway Brook, . .	.13	9.17	.0006	-	-	.14	.0110	.0000	.28	6.7
	Mill Brook, . . .	.11	3.65	.0016	.0132	.0042	.12	.0030	.0000	.29	1.7
	Sacket Brook, . .	.20	5.77	.0015	.0076	.0010	.13	.0140	.0000	.27	5.0
Plymouth, . .	Little South Pond, .	.03	2.97	.0025	.0181	.0031	.72	.0000	.0000	.15	0.2
	Great South Pond, .	.01	3.09	.0015	.0130	.0011	.70	.0002	.0000	.11	0.3
Randolph, . .	Great Pond, . . .	.36	4.75	.0020	.0177	.0012	.74	.0033	.0000	.54	1.4
Rockport, . .	Cape Pond, . . .	.26	11.49	.0023	.0385	.0130	4.01	.0005	.0000	.83	2.1

Averages of Chemical Analyses of Surface-water Sources, etc. — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Free.	Albuminoid.						
					Total.	Sus-pended.		Nitrates.	Nitrites.		
Salem,	Wenham Lake,	.29	6.09	.0097	.0224	.0049	1.01	.0051	.0004	.42	2.3
	Longham Reservoir,	.94	7.26	.0055	.0254	.0049	1.08	.0081	.0003	.90	2.2
Southbridge,	Hatchet Brook Reservoir No. 3.	.30	3.27	.0076	.0201	.0049	.24	.0030	.0000	.42	0.7
	Hatchet Brook Reservoir No. 4.	.32	3.04	.0097	.0184	.0036	.24	.0030	.0000	.44	0.6
South Hadley,	Leaping Well Reservoir,	.09	2.74	.0105	.0252	.0119	.17	.0064	.0001	.14	0.8
	Buttery Brook Reservoir.	.12	3.30	.0043	.0113	.0065	.28	.0170	.0003	.16	1.0
Spencer,	Shaw Pond,	.08	2.81	.0013	.0125	.0010	.20	.0012	.0000	.18	0.9
Springfield,	Westfield Little River, filtered.	.26	4.01	.0011	.0069	-	.15	.0068	.0000	-	1.3
Stockbridge,	Lake Averic,	.13	7.30	.0059	.0184	.0025	.12	.0004	.0000	.32	5.4
Taunton,	Assawompsett Pond,	.23	3.23	.0019	.0182	.0022	.58	.0008	.0000	.37	0.7
	Elder's Pond,	.09	3.23	.0018	.0152	.0010	.58	.0005	.0000	.24	0.5
Wakefield,	Crystal Lake,	.20	5.48	.0036	.0186	.0026	.75	.0062	.0001	.29	2.1
Wareham (Onset),	Jonathan Pond,	.02	2.53	.0014	.0087	.0021	.68	.0003	.0000	.13	0.2
Wayland,	Snake Brook Reservoir,	.74	5.40	.0040	.0272	.0033	.37	.0022	.0000	.83	1.6
Westfield,	Montgomery Reservoir,	.49	3.32	.0053	.0265	.0051	.16	.0007	.0000	.64	0.4
	Tekoa Reservoir,	.35	2.90	.0032	.0169	.0029	.15	.0008	.0000	.51	0.4
	Tillotson Brook Reservoir.	.13	3.25	.0014	.0057	.0006	.16	.0015	.0000	.22	0.6
West Springfield,	Darby Brook Reservoir,	.18	6.22	.0132	.0164	.0075	.29	.0068	.0001	.24	2.9
	Bear Hole Brook, filtered,	.07	6.83	.0011	.0042	-	.18	.0069	.0001	-	4.1
Weymouth,	Great Pond,	.39	3.95	.0034	.0187	.0029	.63	.0013	.0000	.50	0.9
Williamsburg,	Reservoir,	.12	4.43	.0016	.0086	.0013	.13	.0008	.0000	.20	1.9
Winchester,	North Reservoir,	.09	3.95	.0019	.0191	.0029	.50	.0003	.0000	.20	1.7
	South Reservoir,	.11	3.40	.0064	.0170	.0023	.45	.0010	.0000	.19	1.4
	Middle Reservoir,	.19	3.70	.0074	.0280	.0057	.47	.0028	.0001	.28	1.3
Worcester,	Bottomly Reservoir,	.18	3.61	.0035	.0180	.0037	.22	.0067	.0000	.31	1.2
	Kent Reservoir,	.13	3.47	.0041	.0162	.0026	.24	.0018	.0000	.35	1.1
	Leicester Reservoir,	.16	3.45	.0047	.0130	.0015	.25	.0025	.0000	.28	1.1
	Mann Reservoir,	.13	3.31	.0029	.0148	.0025	.22	.0023	.0000	.29	1.2
	Upper Holden Reservoir,	.17	2.51	.0048	.0138	.0033	.21	.0018	.0000	.25	0.6
	Lower Holden Reservoir,	.10	2.49	.0033	.0111	.0018	.22	.0012	.0000	.19	0.7

Averages of Chemical Analyses of Ground-water Sources for the Year 1910.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Adams, . . .	Tubular wells, . . .	.03	8.40	.0003	.0026	.09	.0240	.0000	7.3	.0160
Attleborough, . .	Large well, ...	.02	4.74	.0010	.0036	.48	.0146	.0000	2.2	.0074
Avon, . . .	Wells, ...	.02	5.57	.0003	.0017	.49	.0483	.0000	1.8	.0153
Ayer, . . .	Large well, ...	.00	5.92	.0002	.0021	.76	.0330	.0000	2.4	.0048
	Tubular wells, . . .	.00	4.84	.0008	.0010	.17	.0018	.0000	2.0	.0118
Bedford, . . .	Large well, ...	06	5.11	.0011	.0027	.36	.0027	.0000	1.7	.0250
Billerica, . . .	Tubular wells, . . .	.14	6.35	.0018	.0041	.37	.0037	.0000	2.4	.0448
Braintree, . .	Filter-gallery, . . .	.07	5.98	.0032	.0067	1.06	.0252	.0000	1.8	.0043
Bridgewater, . .	Wells, ...	.11	9.30	.0004	.0026	.51	.0095	.0000	3.8	.0412
Brookfield (East), .	Tubular wells, . . .	.00	3.02	.0004	.0012	.20	.0057	.0000	0.5	.0038
Brookline, . .	Tubular wells and filter-gallery.	.20	9.57	.0055	.0065	.72	.0246	.0001	4.8	.0465
Canton, . . .	Springdale well, . . .	.00	5.17	.0006	.0020	.45	.0247	.0000	1.5	.0120
	Well near Henry's Spring, .	.02	4.42	.0003	.0022	.47	.0340	.0000	1.4	.0035
Chelmsford (North),	Tubular wells, . . .	.13	3.95	.0054	.0046	.39	.0277	.0002	1.3	.0458
Chicopee (Fairview),	Tubular wells, . . .	.02	3.64	.0000	.0009	.11	.0013	.0000	0.6	.0170
Cohasset, . .	Tubular wells No. 1, . .	.01	14.20	.0005	.0012	1.88	.0350	.0000	6.1	.0055
	Tubular wells No. 2, . .	.06	13.13	.0004	.0046	1.90	.1092	.0000	5.5	.0043
	Filter-gallery, . . .	.44	11.90	.2730	.0187	1.27	.0047	.0004	5.4	.0790
	Large well, ...	.50	10.71	.0098	.0143	1.68	.0091	.0002	3.5	.2023
Dedham, . .	Large well and tubular wells,	.02	10.08	.0012	.0034	.98	.1392	.0000	4.0	.0065
Dracut (Water supply District.)	Tubular wells, . . .	.02	8.78	.0004	.0012	.42	.0459	.0001	4.1	.0082
Dracut (Collinsville,	Tubular wells, . . .	.08	10.57	.0009	.0046	.32	.0217	.0000	4.8	.0577
Easthampton, .	Tubular wells, . . .	.00	7.94	.0001	.0013	.13	.0210	.0000	3.8	.0113
Easton, . . .	Well, ...	.01	4.43	.0007	.0023	.58	.0420	.0000	1.6	.0063
Edgartown, . .	Tubular wells, . . .	.00	3.85	.0003	.0010	.93	.0007	.0000	0.4	.0027
Fairhaven, . .	Tubular wells, . . .	.43	7.65	.0008	.0092	1.15	.0510	.0000	2.5	.0063
Foxborough, . .	Tubular wells, . . .	.00	3.30	.0008	.0011	.39	.0350	.0001	1.0	.0040
Framingham, . .	Filter-gallery, . . .	.06	8.40	.0049	.0066	.83	.0210	.0001	3.8	.0115
Franklin, . .	Tubular wells, . . .	.00	3.10	.0004	.0012	.28	.0229	.0000	0.8	.0054
Grafton, . . .	Filter-gallery, . . .	.10	8.77	.0012	.0047	1.12	.1443	.0000	3.6	.0117
Groton, . . .	Large well, ...	.00	6.93	.0000	.0012	.21	.0027	.0000	3.0	.0067
Hingham, . .	Wells, ...	.03	5.77	.0034	.0033	.73	.0112	.0000	2.0	.0092
Hopkinton, . .	Tubular wells, . . .	.00	14.23	.0002	.0021	1.22	.3267	.0000	5.6	.0063
Hyde Park, . .	Tubular wells near Neponset River.	.18	16.24	.0276	.0048	2.49	.0707	.0003	6.4	.0783

Averages of Chemical Analyses of Ground-water Sources, etc. — Continued.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.		Chlorine.	NITROGEN AS		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Hyde Park — *Con.*	Tubular wells near Mother Brook.	.19	8.63	.0006	.0084	1.05	.1052	.0000	3.1	.0067
Kingston,	Tubular wells,	.02	4.80	.0001	.0015	.77	.0090	.0000	1.4	.0050
Leicester,	Wells,	.14	5.93	.0001	.0042	.27	.0493	.0000	2.7	.0810
Lowell,	Boulevard wells (tubular),	.31	5.31	.0340	.0061	.33	.0071	.0001	2.1	.1398
Manchester,	Large well,	.01	11.40	.0007	.0008	1.88	.1630	.0004	4.2	.0194
Mansfield,	Large well,	.00	4.58	.0005	.0014	.42	.0463	.0000	1.4	.0052
Marblehead,	Wells Nos. 1 and 2,	.04	31.45	.0008	.0025	6.53	.0153	.0000	13.6	.0206
	Well No. 2, filtered,	.01	22.60	.0005	.0026	1.83	.0056	.0000	10.4	.0061
Marion,	Tubular wells,	.00	4.54	.0002	.0010	.72	.0165	.0000	1.0	.0096
Marshfield,	Well,	.00	25.20	.0006	.0018	8.80	.1050	.0000	6.3	.0040
Medfield,	Spring,	.02	9.30	.0094	.0206	.82	.0460	.0001	3.4	.0140
Merrimac,	Tubular wells,	.00	6.23	.0005	.0016	.51	.0342	.0000	2.2	.0040
Methuen,	Tubular wells,	.24	7.95	.0016	.0073	.38	.0135	.0000	3.3	.0238
Middleborough,	Well,	.29	6.27	.0046	.0062	.66	.0332	.0000	2.3	.1572
Millbury,	Well,	.03	5.97	.0004	.0024	.38	.0172	.0000	2.3	.0091
Millis,	Spring,	.00	8.20	.0008	.0066	.71	.1600	.0000	3.0	.0120
Monson,	Large well,	.00	3.70	.0004	.0009	.15	.0090	.0000	1.1	.0083
Natick,	Large well,	.01	8.90	.0003	.0021	.65	.0273	.0000	4.5	.0057
Needham,	Well No. 1,	.00	7.10	.0002	.0019	.75	.1083	.0000	2.4	.0052
	Well No. 2,	.00	6.48	.0002	.0018	.74	.1050	.0000	2.5	.0048
	Hick's Spring,	.01	5.72	.0007	.0043	.59	.0877	.0000	1.9	.0063
Newburyport,	Wells and springs,	.07	8.71	.0014	.0065	1.11	.0224	.0000	3.2	.0239
Newton,	Tubular wells and filter-gallery.	.03	6.33	.0009	.0025	.49	.0240	.0001	2.8	.0097
No. Attleborough,	Old well,	.00	6.62	.0004	.0017	.59	.0278	.0000	2.7	.0065
Oak Bluffs,	Springs,	.00	4.30	.0003	.0018	.98	.0114	.0000	0.9	.0056
Oxford,	Tubular wells,	.00	4.18	.0002	.0013	.30	.0303	.0000	1.7	0048
Palmer (Bondsville),	Tubular wells,	.00	5.73	.0002	.0010	.18	.0150	.0000	1.9	.0079
Pepperell,	Tubular wells,	.01	4.01	.0001	.0008	.18	.0007	.0000	1.3	.0040
Plainville,	Tubular wells,	.11	5.08	.0001	.0012	.31	.0008	.0000	2.2	.0461
Provincetown,	Tubular wells in Truro,	.00	6.60	.0002	.0008	2.33	.0061	.0000	1.3	.0056
Reading,	Filter-gallery,	.77	12.21	.0176	.0146	3.00	.0033	.0001	2.8	.2087
	Filtered water,	.26	17.77	.0166	.0092	3.09	.0040	.0002	7.9	.0347
Scituate,	Tubular wells,	.01	16.84	.0003	.0012	3.62	.2140	.0000	6.1	.0062
Sharon,	Well,	.00	10.92	.0003	.0011	1.38	.3000	.0000	4.6	.0138

Averages of Chemical Analyses of Ground-water Sources, etc. — Concluded.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.		Chlorine.	NITROGEN AS		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Sheffield,	Spring,	.01	3.30	.0006	.0012	.08	.0033	.0000	1.7	.0037
Shirley,	Well,	.00	2.92	.0003	.0010	.22	.0195	.0000	0.7	.0042
Tisbury,	Well,	.06	4.10	.0015	.0013	1.02	.0030	.0000	0.4	.0030
Uxbridge,	Tubular wells,	.01	4.63	.0002	.0013	.56	.0783	.0000	1.6	.0040
Walpole,	Tubular wells,	.00	4.80	.0006	.0013	.42	.0373	.0000	1.6	.0053
Waltham,	Old well,	.15	8.09	.0045	.0041	.79	.0216	.0000	3.5	.0575
	New well,	.00	7.42	.0007	.0040	.58	.0185	.0000	3.4	.0068
Ware,	Wells,	.00	5.97	.0005	.0012	.36	.1150	.0000	2.2	.0055
Wareham (Fire District),	Tubular wells,	.01	3.45	.0005	.0013	.60	.0014	.0000	0.8	.0090
Webster,	Wells,	.02	4.60	.0008	.0022	.30	.0100	.0000	1.9	.0208
Wellesley,	Tubular wells,	.00	9.21	.0003	.0018	.98	.0964	.0000	4.1	.0043
	Well at Williams Spring,	.00	13.95	.0011	.0020	1.30	5558	.0000	5.1	.0107
Westborough,	Filter basin,	.04	3.17	.0020	.0102	.27	.0002	.0000	1.3	.0135
Westford,	Tubular wells,	.00	4.19	.0003	.0008	.18	.0073	.0000	1.2	.0065
Weston,	Well,	.21	8.53	.0014	.0095	.58	.0248	.0000	3.7	.0095
Winchendon,	Well,	.22	3.00	.0013	.0023	.14	.0040	.0000	0.8	.0970
Woburn,	Filter-gallery and wells,	.02	10.47	.0043	.0040	1.33	.0172	.0000	5.0	.0030
Wrentham,	Tubular wells,	.00	3.12	.0002	.0010	.31	.0023	.0000	1.0	.0035

EXAMINATION OF RIVERS.

EXAMINATION OF RIVERS.

All of the larger rivers of the State are polluted in a greater or less degree by the sewage of cities or towns or by manufacturing wastes from factories and mills located upon their banks, and to some extent from other causes incident to regions as populous as are most of the river valleys of Massachusetts. In some cases the pollution is slight and detectable only by analysis unless in the immediate vicinity of the outlet of a sewer or below a factory or mill discharging wastes from manufacturing processes in which the water used is more or less fouled. In other cases the pollution caused by the discharge of sewage or manufacturing waste at a city, town or village is so great that the river has an objectionable appearance and a noticeable odor for a long distance; and in some cases the pollution is so great as to render the stream filthy and offensive for many miles.

The year 1910 was one of the driest on record, and the rainfall, though much greater than the average in January and February, was much lower for the year than in any year for more than a quarter of a century. The effect of this extremely low rainfall has been to diminish the flow of streams to a smaller quantity than in the years of low rainfall immediately preceding, and to reduce the dilution of sewage and other polluting matters discharged into the streams to a lower degree than has been the case in many years.

On nearly all of the important streams of the State stations were established many years ago at which samples of the water have been collected for chemical examination to determine the changes taking place from time to time in the condition of the water. The samples are for the most part collected during the six driest months of the year, from June to November inclusive, since in this part of the year the dilution of sewage in polluted streams is least and the effect of pollution most noticeable; though in a few cases samples are collected monthly throughout the year. During the year 1910 chemical analyses were made of samples of water collected from the following streams at monthly intervals, in some cases during the entire year: —

Assabet.
Blackstone.
Charles.
Chicopee.
Concord.
Connecticut.
Deerfield.
French.
Green.
Hoosick.
Housatonic.
Merrimack.
Mill (Northampton).
Miller's.
Nashua.
Nemasket.
Neponset.
Quaboag.
Quinebaug.
Salisbury Plain.
Shawsheen.
Sudbury.
Taunton.
Ten Mile.
Ware.
Westfield.

BLACKSTONE RIVER.

The Blackstone River is polluted by wastes discharged from mills in Cherry Valley, chiefly in the town of Leicester and the upper part of the city of Worcester, and in places in this region has been offensive during the past year. It evidently receives considerable additional pollution between Cherry Valley and the next observation station located a short distance above the Worcester precipitation works. Below this point the river receives the effluent from the precipitation works and the filter beds for the disposal of the sewage of the city of Worcester. Farther down-stream considerable pollution is added to the stream from factories in the various villages along its course.

BLACKSTONE RIVER.

BLACKSTONE RIVER.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Blackstone River, below Cherry Valley.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908,	–	20.57	3.83	.1531	.0624	.0508	.0116	5.76	.0020	.0007	–	-
1909,	.35	13.93	3.34	.0681	.0470	.0334	.0136	3.70	.0125	.0003	.80	-
1910,	.32	16.42	3.92	.0633	.0489	.0387	.0102	4.02	.0146	.0002	.85	-

BLACKSTONE RIVER.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER, ETC. — *Continued.*

Blackstone River, between Mill Brook Channel and the Sewage Precipitation Works of the City of Worcester.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Hardness.
					ALBUMINOID.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
1887, ...	0.91	-	-	.2686	.1741	-	-	1.35	.0160	-	-
1888, ...	0.76	-	-	.2658	.1112	.0557	.0555	1.50	.0382	.0041	-
1889, ...	0.86	-	-	.3980	.1430	.0772	.0658	1.32	.0177	.0026	-
1890, ...	1.14	9.92	3.03	.2107	.1246	.0673	.0573	1.07	.0250	.0015	2.9
1891, ...	1.10	17.42	5.59	.4913	.1950	.1127	.0823	2.29	.0192	.0037	5.0
1892, ...	0.52	20.75	6.30	.3547	.1433	.0708	.0725	2.43	.0227	.0108	6.1
1893, ...	0.40	16.98	4.55	.1480	.0588	.0240	.0348	1.01	.0115	.0015	6.3
1894, ...	0.66	16.93	4.76	.0548	.0380	.0236	.0144	0.74	.0115	.0005	4.4
1895, ...	0.49	14.17	4.50	.0613	.0414	.0243	.0171	0.92	.0163	.0006	3.4
1896, ...	0.51	12.90	2.93	.0780	.0415	.0282	.0133	0.97	.0147	.0015	3.4
1897, ...	0.85	26.45	7.68	.1130	.0674	.0362	.0312	0.89	.0090	.0024	4.2
1898, ...	0.33	17.42	5.62	.0857	.0619	.0260	.0359	0.96	.0053	.0010	4.6
1899, ...	0.14	34.38	10.60	.2583	.0788	.0390	.0398	-	-	.0004	14.3
1900, ...	0.05	16.48	3.38	.1068	.0518	.0210	.0308	1.03	.0107	.0012	3.6
1901, ...	0.23	31.03	11.68	.1410	.0548	.0309	.0239	-	-	.0023	18.8
1902, ...	0.10	46.15	12.47	.2453	.0728	.0274	.0454	-	-	.0010	16.5
1903, ...	0.18	24.06	6.80	.2836	.0750	.0472	.0278	-	-	.0027	8.4
1904, ...	0.12	44.68	17.08	.1228	.0434	.0225	.0209	-	-	.0008	14.7
1905, ...	0.21	50.36	19.49	.0952	.0492	.0203	.0289	-	-	.0003	29.3
1906, ...	0.11	40.07	15.25	.0688	.0421	.0189	.0232	-	.0032	.0002	20.3
1907, ...	0.04	44.07	17.67	.0613	.0343	.0180	.0163	-	-	.0003	-
1908, ...	0.16	23.67	5.55	.0990	.0291	.0153	.0138	3.23	.0134	.0014	-
1909, ...	-	52.97	18.55	.1865	.0381	.0239	.0142	4.80	.0033	.0010	-
1910, ...	0.15	50.92	18.97	.1933	.0545	.0309	.0236	4.07	.0023	.0009	-

Blackstone River, below Sewage Precipitation Works.

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Hardness.
					ALBUMINOID.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
1887, ...	0.91	-	-	.2686	.1741	-	-	1.35	.0160	-	-
1888, ...	0.76	-	-	.2658	.1112	.0557	.0555	1.50	.0382	.0041	-
1889, ...	0.86	-	-	.3980	.1430	.0772	.0658	1.32	.0177	.0026	-
1890, ...	0.97	11.36	3.10	.2907	.1492	.0722	.0770	1.46	.0270	.0018	3.9
1891, ...	1.05	22.25	6.60	.6367	.1508	.0883	.0625	2.61	.0233	.0040	6.2
1892, ...	0.63	26.80	7.75	.5240	.1810	.0958	.0852	3.13	.0137	.0050	10.3
1893, ...	0.51	30.00	7.13	.5680	.1453	.0900	.0553	2.76	.0285	.0126	10.9
1894, ...	0.40	29.30	5.86	.6189	.1390	.1113	.0277	2.63	.0212	.0071	10.6
1895, ...	0.71	22.15	5.18	.3246	.0898	.0597	.0301	1.86	.0267	.0063	7.3
1896, ...	0.30	26.03	6.53	.2831	.0898	.0600	.0298	2.10	.0217	.0118	9.7
1897, ...	0.73	25.98	4.97	.3650	.1122	.0782	.0340	1.61	.0207	.0063	6.9
1898, ...	0.23	25.63	6.73	.3064	.0868	.0560	.0308	1.55	.0132	.0119	9.2
1899, ...	0.14	44.02	9.67	.5251	.1707	.0912	.0795	3.26	.0108	.0068	16.1
1900, ...	0.22	24.57	4.48	.4430	.1249	.0621	.0628	2.13	.0110	.0145	7.3
1901, ...	0.09	31.12	6.90	.4580	.1293	.0772	.0521	3.42	.0090	.0058	10.8
1902, ...	0.15	49.62	13.38	.7296	.1284	.0736	.0548	2.97	-	.0033	12.5
1903, ...	0.39	31.08	9.48	.3880	.1080	.0545	.0535	-	-	.0062	10.4
1904, ...	-	50.25	13.73	.6381	.1523	.0601	.0922	-	-	.0027	16.9
1905, ...	0.19	59.84	17.97	.4936	.0985	.0597	.0388	-	-	.0008	29.3
1906, ...	0.19	49.69	11.42	.6330	.1818	.0580	.1238	-	.0058	.0130	15.0
1907, ...	0.37	40.40	7.87	.7600	.0837	.0580	.0257	5.15	.0255	.0061	-
1908, ...	0.46	37.70	6.82	1.1317	.1362	.0919	.0443	6.80	.0078	.0040	-
1909, ...	-	48.82	9.29	1.2200	.1072	.0777	.0295	8.20	.0140	.0069	-
1910, ...	-	52.38	11.13	1.3033	.1265	.0892	.0373	8.07	.0108	.0046	-

Chemical Examination of Water from Blackstone River, etc. — *Concluded.*

Blackstone River, at Uxbridge.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.	
					Total.	Dissolved.	Suspended.				
1887,	.39	-	-	.1129	.0271	-	-	0.79	.0360	-	-
1888,	.38	6.42	1.52	.1155	.0288	.0222	.0066	0.68	.0310	.0007	-
1889,	.32	-	-	.1133	.0296	.0192	.0104	0.66	.0333	.0009	-
1890,	.26	8.86	2.12	.1629	.0231	.0174	.0057	0.79	.0259	.0006	2.9
1891,	.20	10.16	2.61	.2280	.0175	.0117	.0058	1.04	.0425	.0007	3.6
1892,	.13	9.36	1.88	.2840	.0227	.0162	.0065	0.99	.0313	.0007	3.1
1893,	.24	11.74	2.37	.1985	.0207	.0140	.0067	1.20	.0623	.0050	4.2
1894,	.35	13.07	2.03	.1456	.0243	.0183	.0060	1.57	.0673	.0050	4.9
1895,	.56	12.95	2.69	.0906	.0258	.0182	.0076	1.34	.0631	.0065	4.7
1896,	.33	12.68	2.67	.1129	.0257	.0221	.0036	1.38	.0477	.0091	5.0
1897,	.48	11.60	2.47	.1029	.0280	.0215	.0065	1.32	.0652	.0061	4.3
1898,	.49	10.59	2.78	.0801	.0264	.0219	.0045	1.00	.0470	.0076	3.8
1899,	.18	18.34	3.11	.2490	.0359	.0310	.0049	2.17	.0510	.0141	7.4
1900,	.19	13.42	2.04	.2260	.0347	.0257	.0090	1.76	.0558	.0060	5.0
1901,	.22	13.91	2.67	.3159	.0285	.0240	.0045	1.50	.0195	.0035	5.0
1902,	.15	14.17	2.56	.3462	.0270	.0218	.0052	1.95	.0210	.0018	4.9
1903,	.30	13.16	2.52	.3030	.0262	.0215	.0047	1.74	.0210	.0024	4.4
1904,	.20	13.78	2.74	.2399	.0282	.0214	.0068	2.12	.0408	.0022	4.6
1905,	.21	16.34	2.55	.3928	.0246	.0203	.0043	2.65	.0175	.0025	5.0
1906,	.19	14.73	3.10	.2218	.0242	.0200	.0042	2.10	.0252	.0009	4.2
1907,	.37	14.23	2.58	.2331	.0238	.0182	.0056	2.36	.0330	.0040	4.5
1908,	.31	16.33	4.07	.2387	.0253	.0196	.0057	3.05	.0408	.0071	-
1909,	.22	18.31	4.35	.3473	.0273	.0216	.0057	3.64	.0325	.0066	-
1910,	.26	22.53	4.69	.4963	.0356	.0302	.0054	4.62	.0498	.0043	-

Blackstone River, at Millville.

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.	
					Total.	Dissolved.	Suspended.				
1887,	.31	-	-	.0468	.0220	-	-	0.51	.0210	-	-
1888,	.41	5.22	1.40	.0467	.0296	.0233	.0063	0.50	.0278	.0004	-
1889,	.38	-	-	.0499	.0273	.0213	.0060	0.45	.0167	.0003	-
1890,	.26	6.71	2.24	.0736	.0196	.0152	.0044	0.53	.0229	.0003	2.3
1891,	.24	7.48	2.35	.1105	.0384	.0234	.0150	0.72	.0308	.0006	2.2
1892,	.37	6.70	1.62	.1143	.0294	.0210	.0084	0.63	.0217	.0002	2.0
1893,	.23	7.43	1.73	.0677	.0119	.0087	.0032	0.77	.0385	.0011	2.6
1894,	.47	8.42	2.16	.0510	.0172	.0139	.0033	0.89	.0273	.0012	2.8
1895,	.51	8.67	2.55	.0356	.0233	.0180	.0053	0.90	.0383	.0024	3.2
1896,	.35	8.53	1.69	.0484	.0237	.0180	.0057	0.97	.0413	.0027	3.3
1897,	.45	7.66	1.98	.0509	.0258	.0210	.0048	0.92	.0445	.0019	3.1
1898,	.51	7.12	2.17	.0325	.0240	.0193	.0047	0.63	.0240	.0023	2.5
1899,	.20	12.50	2.44	.1310	.0301	.0247	.0054	1.31	.0310	.0049	4.6
1900,	.29	9.33	1.82	.1168	.0254	.0219	.0035	1.15	.0417	.0039	3.4
1901,	.31	8.62	2.13	.1420	.0288	.0227	.0061	0.87	.0155	.0006	3.1
1902,	.28	9.43	2.24	.1623	.0284	.0238	.0046	1.20	.0195	.0010	2.8
1903,	.33	8.46	1.85	.1397	.0233	.0189	.0044	1.10	.0192	.0010	2.9
1904,	.29	8.71	2.06	.1079	.0235	.0201	.0034	1.26	.0337	.0009	2.9
1905,	.28	10.76	2.03	.1956	.0311	.0222	.0089	1.67	.0207	.0008	2.9
1906,	.37	9.02	2.15	.1526	.0306	.0251	.0055	1.27	.0188	.0006	2.4
1907,	.37	10.43	2.21	.1521	.0240	.0181	.0059	1.61	.0247	.0014	3.1
1908,	.33	9.85	2.53	.1295	.0232	.0185	.0047	1.78	.0258	.0024	3.4
1909,	.24	11.87	3.17	.1595	.0267	.0220	.0047	2.27	.0225	.0019	-
1910,	.30	13.94	3.32	.2350	.0277	.0234	.0043	3.01	.0290	.0013	-

Note. — The sewage purification works of the city of Worcester were put in operation in 1890, since which time a portion of the sewage of the city has been treated. The works were enlarged in 1893 and since that time practically all of the dry-weather flow of sewage has been treated.

CHARLES RIVER.

The Charles River still receives considerable pollution at Milford, though a sewerage system has recently been constructed there which is intended to provide for the diversion of the sewage from the river. One of the tributaries of this river is also greatly polluted by sewage and manufacturing wastes in the town of Franklin. Farther down-stream the Charles River is the indirect source of water supply for the towns of Dedham and Brookline and the cities of Newton and Waltham. It also receives some pollution from manufacturing wastes in the lower part of its course in Newton, Waltham and Watertown.

CHARLES RIVER.

CHEMICAL EXAMINATION OF WATER FROM CHARLES RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Charles River, above Milford.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
					Total.	Dissolved.	Suspended.					
1899,	.28	3.98	1.70	.0017	.0248	.0223	.0025	.27	.0027	.0003	.48	0.6
1900,	.49	3.93	1.67	.0017	.0251	.0231	.0020	.25	.0030	.0000	.64	0.5
1901,	.46	4.30	2.48	.0066	.0286	.0247	.0039	.25	.0060	.0002	.65	0.6
1902,	.58	4.42	1.90	.0025	.0248	.0210	.0038	.29	.0057	.0001	.70	1.1
1903,[1]	.56	4.17	1.86	.0015	.0208	.0171	.0032	.28	.0080	.0001	.68	0.8
1904,[2]	.49	3.95	1.83	.0117	.0267	.0209	.0058	.33	.0035	.0001	.62	1.1
1905,[3]	.55	3.77	1.62	.0020	.0229	.0201	.0028	.31	.0033	.0001	.56	0.8
1906,[3]	.62	4.05	1.90	.0032	.0257	.0230	.0027	.30	.0073	.0001	.68	0.6
1907,	.43	3.79	1.59	.0020	.0198	.0173	.0025	.32	.0047	.0001	.48	0.8
1908,	.36	3.11	1.43	.0023	.0198	.0171	.0027	.33	.0025	.0001	.42	0.5
1909,	.31	3.52	1.62	.0030	.0207	.0176	.0031	.32	.0012	.0000	.39	0.7
1910,	.37	3.47	1.34	.0042	.0231	.0204	.0027	.37	.0011	.0001	.46	0.8

[1] October omitted. [2] Two months. [3] Three months.

Charles River, below Milford.

1898,	.63	10.47	3.06	.1195	.0597	.0422	.0175	2.47	.0473	.0064	.69	2.4
1899,	.50	12.52	3.12	.3487	.1345	.0803	.0542	3.00	.0053	.0008	1.12	2.6
1900,	.56	12.85	2.65	.7123	.0764	.0563	.0201	2.74	.0140	.0055	.93	3.1
1901,	.63	9.52	3.37	.1419	.0451	.0317	.0134	1.40	.0422	.0048	.86	2.6
1902,	.52	10.74	3.38	.2118	.0658	.0406	.0252	2.21	.0236	.0049	1.02	2.7
1903,[1]	.49	9.03	2.85	.2237	.0479	.0277	.0202	1.36	.0396	.0050	.66	2.5
1904,[2]	.50	9.20	2.94	.2105	.0508	.0350	.0158	1.44	.0513	.0055	.63	2.6
1906,[3]	.68	8.76	2.90	.1536	.0568	.0427	.0141	1.64	.0160	.0012	.92	2.0
1907,	.54	12.95	2.83	.4607	.0864	.0525	.0339	2.94	.0352	.0021	.86	3.2
1908,	.48	10.81	3.48	.3925	.0598	.0347	.0251	1.79	.0218	.0049	.64	–
1909,	.50	12.66	4.07	.5658	.0479	.0399	.0060	1.89	.0273	.0064	.72	–
1910,	.57	15.21	3.83	.8038	.0640	.0499	.0141	3.01	.0248	.0082	.88	4.2

[1] November omitted. [2] Four months. [3] June omitted.

CHARLES RIVER.

CHEMICAL EXAMINATION OF WATER FROM CHARLES RIVER, ETC. — *Concluded.*

Charles River, opposite Pumping Station of Brookline Water Works.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887, ...	.83	5.37	1.62	.0013	.0282	-	-	.44	.0087	-	-	-
1888, ...	.98	4.87	1.92	.0014	.0264	.0240	.0024	.37	.0062	.0002	-	-
1895, ...	.74	4.91	2.08	.0004	.0237	.0207	.0030	.48	.0055	.0001	.75	1.5
1897, ...	1.02	5.36	2.45	.0012	.0288	.0262	.0026	.43	.0067	.0001	.86	1.5
1898, ...	.87	5.22	2.40	.0012	.0303	.0281	.0022	.39	.0035	.0001	.92	1.4
1899, ...	.46	5.03	1.92	.0011	.0262	.0230	.0032	.45	.0025	.0001	.62	1.5
1900, ...	.56	4.96	1.60	.0018	.0252	.0229	.0023	.46	.0020	.0000	.70	1.4
1901, ...	.92	5.45	2.60	.0020	.0314	.0275	.0039	.41	.0047	.0001	.95	1.4
1902, ...	.52	5.46	2.03	.0031	.0234	.0211	.0023	.57	.0045	.0001	.64	1.6
1903, ...	.71	6.22	2.30	.0031	.0240	.0223	.0017	.53	.0065	.0001	.80	1.5
1904, ...	.51	5.24	2.17	.0021	.0224	.0208	.0016	.55	.0060	.0001	.67	1.6
1905,[1]	.84	5.93	2.60	.0029	.0318	.0277	.0041	.54	.0056	.0002	.92	1.5
1906,[1]	1.05	6.00	2.77	.0039	.0294	.0267	.0027	.53	.0032	.0001	1.17	1.4
1907,[1]	.63	6.15	2.40	.0022	.0246	.0228	.0018	.64	.0026	.0001	.73	1.7
1908,[1]	.55	5.93	2.29	.0035	.0248	.0222	.0026	.65	.0036	.0002	.61	1.7
1909,[2]	.65	5.75	2.00	.0023	.0254	.0236	.0018	.69	.0015	.0001	.75	1.5
1910, ...	.60	6.71	2.79	.0028	.0289	.0260	.0029	.83	.0013	.0001	.72	1.8

[1] Five months. [2] Two months.

Charles River, opposite Pumping Station of Waltham Water Works.

1887, ...	.67	6.02	1.62	.0029	.0274	-	-	.48	.0043	-	-	-
1888, ...	.82	5.47	1.88	.0035	.0310	.0265	.0045	.41	.0087	.0002	-	-
1897, ...	.95	6.06	2.45	.0056	.0322	.0299	.0023	.53	.0073	.0002	.83	1.9
1898, ...	.81	5.74	2.46	.0050	.0329	.0296	.0033	.44	.0043	.0001	.85	1.6
1899, ...	.41	5.50	1.81	.0047	.0264	.0248	.0016	.51	.0051	.0002	.52	1.9
1900, ...	.52	5.93	1.68	.0064	.0282	.0259	.0023	.53	.0070	.0002	.58	1.7
1901, ...	.82	5.93	2.72	.0065	.0322	.0289	.0033	.44	.0067	.0002	.85	1.8
1902, ...	.45	6.21	1.97	.0084	.0258	.0228	.0030	.62	.0077	.0003	.59	2.0
1903, ...	.64	6.06	2.21	.0078	.0267	.0239	.0028	.58	.0084	.0003	.71	2.0
1904, ...	.55	6.08	2.22	.0062	.0317	.0266	.0051	.62	.0095	.0002	.62	2.0
1905, ...	.79	6.29	2.54	.0077	.0363	.0308	.0055	.58	.0075	.0002	.80	1.7
1906, ...	1.00	6.70	2.58	.0063	.0335	.0297	.0038	.59	.0038	.0002	.98	1.8
1907,[1]	.58	6.22	2.24	.0067	.0278	.0247	.0031	.63	.0058	.0002	.65	2.0
1908, ...	.62	6.50	2.49	.0048	.0344	.0284	.0060	.69	.0027	.0001	.64	1.9
1909, ...	.54	6.79	2.36	.0063	.0349	.0298	.0051	.76	.0026	.0002	.53	2.0
1910, ...	.59	7.37	2.87	.0078	.0336	.0299	.0037	.81	.0037	.0003	.56	2.4

[1] July omitted.

CHICOPEE RIVER.

The drainage area of the Chicopee River is wholly within the State of Massachusetts. It has three principal tributaries, — the Quaboag River in the southerly part of its watershed, the Ware River in the central portions and the Swift River in the northwest.

The Quaboag River receives considerable pollution along its course, chiefly at Palmer, where the sewage of the town is discharged untreated into the river. The Ware River is polluted seriously by manufacturing wastes at several points, especially at Ware, where the sewage of the town is discharged untreated into the stream. At Barre, where a large wool-scouring establishment is located, works for treating the wastes have been installed during the year. The Swift River receives very little pollution except from the sewage and manufacturing wastes discharged into it at the village of Bondsville in the town of Palmer.

The main Chicopee River is polluted considerably by the sewage of Ludlow and a portion of the city of Chicopee.

CHEMICAL EXAMINATION OF WATER FROM CHICOPEE RIVER AND ITS TRIBUTARIES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Ware River, below Ware.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	ALBUMINOID.				Nitrates.	Nitrites.		
					Total.	Dissolved.	Suspended.					
1898, ...	.64	4.42	1.94	.0028	.0332	.0250	.0082	.19	.0025	.0003	.77	1.0
1899, ...	.46	4.82	1.77	.0052	.0371	.0268	.0103	.25	.0015	.0004	.66	0.9
1900, ...	.51	4.93	1.64	.0066	.0321	.0243	.0078	.25	.0030	.0003	.73	1.1
1901, ...	.73	4.79	2.15	.0082	.0300	.0242	.0058	.18	.0044	.0002	.84	1.3
1902, ...	.76	4.86	2.17	.0071	.0348	.0252	.0096	.23	.0040	.0003	.93	1.0
1903,[1]	.68	4.83	2.18	.0072	.0345	.0240	.0106	.25	.0034	.0003	.78	0.8
1904,[1]	.60	5.60	2.36	.0043	.0411	.0285	.0126	.29	.0046	.0004	.72	1.1
1908, ...	.56	7.38	2.86	.0265	.0418	.0264	.0154	.37	.0033	.0005	.80	-
1909,[1]	.61	8.63	3.05	.0354	.0569	.0357	.0212	.44	.0015	.0006	.98	-
1910, ...	.57	9.82	4.37	.0655	.0622	.0426	.0196	.60	.0040	.0011	.84	-

[1] September omitted.

CHICOPEE RIVER.

CHEMICAL EXAMINATION OF WATER FROM CHICOPEE RIVER AND ITS TRIBUTARIES, ETC. — *Concluded.*

Quaboag River, below Palmer.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899, . . .	.35	4.54	1.68	.0048	.0252	.0208	.0044	.26	.0060	.0002	.44	1.1
1900, . . .	.40	4.56	1.58	.0038	.0218	.0176	.0042	.26	.0062	.0001	.48	1.2
1901, . . .	.42	4.32	1.74	.0043	.0255	.0202	.0053	.23	.0052	.0002	.53	1.1
1902, . . .	.41	4.55	1.64	.0077	.0242	.0196	.0046	.33	.0085	.0002	.53	1.2
1903, . . .	.44	4.36	1.67	.0090	.0242	.0186	.0056	.27	.0092	.0003	.51	1.0
1904, . . .	.40	4.68	1.70	.0191	.0253	.0195	.0058	.31	.0082	.0002	.50	1.1
1908, . . .	.36	5.31	1.98	.0061	.0207	.0149	.0058	.40	.0070	.0003	.42	-
1909, . . .	.31	5.43	1.95	.0068	.0211	.0165	.0046	.41	.0058	.0003	.47	-
1910, . . .	.44	6.05	2.28	.0043	.0238	.0168	.0070	.52	.0057	.0003	.73	-

Swift River, below Bondsville.

1908,[1] . . .	.34	5.45	2.42	.0047	.0217	.0132	.0085	.21	.0013	.0002	.44	-
1909,[1] . . .	.40	5.90	2.13	.0373	.0604	.0539	.0065	.38	.0017	.0094	.63	-
1910, . . .	.33	5.28	2.05	.0031	.0261	.0196	.0065	.25	.0010	.0001	.60	-

[1] Three months.

Chicopee River, at Indian Orchard.

1908,[1] . . .	.42	5.21	1.98	.0100	.0240	.0177	.0063	.33	.0056	.0003	.62	-
1909,[1] . . .	.38	5.82	2.08	.0094	.0220	.0162	.0058	.36	.0046	.0004	.46	-
1910, . . .	.45	6.14	2.06	.0099	.0239	.0191	.0048	.44	.0052	.0003	.50	-

[1] Five months.

CONCORD RIVER.

The Concord River and its two principal tributaries, the Sudbury and Assabet, especially the latter stream, receive considerable pollution from sewage and manufacturing wastes.

The Assabet River has been badly polluted recently below the filter beds of the Westborough sewage disposal works, below the town of Hudson and below the town of Maynard, where it is grossly polluted by sewage and manufacturing wastes discharged from woolen mills in that town. The nuisance below Westborough has been due to the inefficient purification of the sewage at the Westborough sewage filtration area, caused chiefly by the discharge of manufacturing wastes containing yeast and alcohol into the sewers from a yeast factory. The factory was closed in the latter part of the summer of 1910 and since that time the purification of the sewage at Westborough has rapidly improved. At Hudson, where a similar difficulty was caused by the discharge of manufacturing wastes, chiefly wool-scouring liquor, into the town sewers, which interfered with the operation of the filter beds, the filters have been enlarged and the wool-scouring wastes are now being treated for the removal of the grease. The effluent from these works is now discharged into the river, and the operation of the filter beds has improved.

The Sudbury River is polluted at Saxonville by wastes from a large woolen mill, the effect of which is noticeable for a long distance downstream.

CONCORD RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONCORD RIVER AND ITS TRIBUTARIES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Sudbury River, below Saxonville.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1901,	.84	7.22	3.37	.0073	.0624	.0431	.0193	.38	.0050	.0005	1.05	1.9
1902,	.38	6.39	2.57	.0150	.0424	.0272	.0152	.60	.0103	.0005	.55	2.2
1903,	.52	7.77	2.78	.0028	.0549	.0296	.0253	.65	.0080	.0002	.83	2.1
1904,	.48	9.58	3.57	.0569	.0587	.0385	.0202	.87	.0193	.0032	.88	2.5
1906,[1]	.67	6.88	2.90	.0258	.0525	.0381	.0144	.56	.0058	.0004	.92	1.9
1907,[2]	.65	9.07	3.28	.1357	.0653	.0347	.0306	.84	.0063	.0004	.84	2.1
1908,[3]	.44	9.67	3.72	.0039	.0634	.0374	.0260	1.06	.0128	.0009	.69	-
1909,	.43	6.81	2.59	.0174	.0330	.0256	.0074	.64	.0043	.0005	.64	-
1910,	.49	9.78	3.45	.0454	.0606	.0345	.0261	.83	.0040	.0010	.65	-

[1] June omitted. [2] Three months. [3] August omitted.

Assabet River, above Westborough.

1909,	.56	6.01	2.20	.0048	.0217	.0194	.0023	.36	.0015	.0001	.69	-
1910,	.90	7.37	3.12	.0029	.0251	.0229	.0022	.38	.0035	.0001	.86	-

Assabet River, below Westborough.

1909,	1.70	19.24	8.91	.4140	.2281	.1616	.0665	1.94	.0005	.0005	2.90	-
1910.	2.23	17.07	7.00	.2898	.1334	.1018	.0316	2.16	.0078	.0018	2.20	-

CONCORD RIVER.

Chemical Examination of Water from Concord River and its Tributaries, etc. — *Continued.*

Assabet River, above Hudson.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908,[1]	.49	5.97	2.16	.0044	.0241	.0200	.0041	.54	.0072	.0003	.59	–
1909, ...	.39	6.37	2.33	.0070	.0306	.0261	.0045	.52	.0037	.0002	.50	–
1910, ...	.57	6.90	3.08	.0058	.0346	.0296	.0050	.61	.0055	.0002	.67	–

[1] September omitted.

Assabet River, below Hudson.

1898, ...	.79	5.61	2.38	.0062	.0335	.0291	.0044	.39	.0063	.0003	.87	1.6
1899, ...	.50	8.30	3.01	.0205	.0457	.0383	.0074	.80	.0020	.0004	.73	2.1
1900, ...	.48	8.05	2.05	.0382	.0501	.0362	.0139	1.27	.0028	.0007	.72	2.0
1901, ...	.66	5.47	2.38	.0193	.0375	.0295	.0080	.79	.0107	.0005	.91	1.8
1902, ...	.64	7.06	2.69	.0189	.0464	.0330	.0134	.84	.0077	.0005	.74	1.9
1903,[1]	.51	5.71	2.17	.0092	.0287	.0222	.0065	.56	.0073	.0006	.60	1.7
1904,[2]	.44	7.67	2.60	.0329	.0375	.0312	.0063	1.43	.0073	.0005	.64	1.9
1908, ...	.51	9.17	3.50	.0198	.0396	.0294	.0102	1.32	.0072	.0005	.82	–
1909, ...	.51	8.81	3.26	.0161	.0403	.0296	.0107	.98	.0022	.0002	.64	–
1910, ...	.69	13.82	3.82	.0413	.0428	.0337	.0091	1.27	.0048	.0002	1.24	–

[1] June omitted. [2] Three months.

Assabet River, above Maynard.

1904, ...	.53	5.65	2.30	.0046	.0275	.0231	.0044	.64	.0035	.0001	.63	1.6
1906, ...	.75	5.53	2.26	.0065	.0290	.0254	.0036	.48	.0035	.0002	.97	1.5
1907,[1]	.68	5.35	1.80	.0047	.0255	.0211	.0044	.50	.0043	.0002	.73	1.6
1908, ...	.52	6.91	2.32	.0093	.0288	.0248	.0040	1.03	.0030	.0002	.62	-
1909, ...	.43	6.18	2.13	.0068	.0343	.0277	.0066	.72	.0023	.0001	.62	-
1910, ...	.54	7.70	2.82	.0098	.0337	.0291	.0046	.98	.0017	.0003	.64	-

[1] Four months.

Assabet River, below Maynard.

1898, ...	.77	5.93	2.59	.0020	.0387	.0301	.0086	.43	.0030	.0003	.89	1.5
1899, ...	.51	6.70	2.21	.0185	.0414	.0327	.0087	.73	.0043	.0003	.62	1.7
1900, ...	.50	5.72	1.73	.0217	.0386	.0304	.0082	.70	.0031	.0002	.59	1.4
1901, ...	.73	6.57	2.67	.0211	.0428	.0351	.0077	.45	.0052	.0002	.90	1.6
1902, ...	.69	7.27	2.87	.0099	.0592	.0381	.0211	.57	.0033	.0002	.83	1.6
1903, ...	.61	6.40	2.58	.0170	.0457	.0322	.0135	.48	.0037	.0003	.83	1.6
1904, ...	-	8.48	3.21	.0143	.0678	.0412	.0266	.74	.0043	.0002	1.05	1.7
1906, ...	.88	6.68	2.64	.0290	.0448	.0312	.0136	.58	.0047	.0003	.91	1.6
1907,[1]	.79	7.64	2.76	.0299	.0391	.0274	.0117	.69	.0060	.0003	.86	1.6
1908, ...	.45	11.46	3.98	.0075	.0684	.0381	.0303	1.37	.0028	.0012	.89	-
1909, ...	-	13.97	4.21	.1208	.0991	.0529	.0462	1.22	.0007	.0006	1.34	-
1910, ...	.59	13.15	4.68	.0708	.0685	.0446	.0239	1.82	.0038	.0006	.85	-

[1] Four months.

CONCORD RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONCORD RIVER AND ITS TRIBUTARIES, ETC. — *Concluded.*

Concord River, at Billerica.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1902, ...	.68	5.98	2.18	.0091	.0347	.0272	.0075	.53	.0052	.0004	.78	1.7
1903, ...	.64	5.71	2.26	.0097	.0317	.0258	.0059	.49	.0058	.0005	.72	1.8
1904, ...	.64	6.05	2.31	.0077	.0341	.0255	.0086	.55	.0072	.0002	.75	1.7
1908, ...	.37	8.04	2.65	.0107	.0251	.0216	.0035	.96	.0104	.0005	.54	-
1909, ...	.49	7.71	2.78	.0128	.0298	.0267	.0031	.75	.0058	.0013	.65	-
1910, ...	.49	7.31	3.00	.0142	.0325	.0292	.0033	1.01	.0055	.0004	.58	-

CONNECTICUT RIVER.

The Connecticut River is the largest stream in the State, with by far the greatest flow of water, which is well maintained in the drier part of the year. There are sewer outlets into the stream at Turners Falls, near the northerly boundary of the State, and at Holyoke, Chicopee, Springfield, West Springfield and other points.

CONNECTICUT RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONNECTICUT RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Connecticut River, above Holyoke.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1904, ...	.29	5.98	2.21	.0018	.0171	.0130	.0041	.15	.0050	.0002	.73	2.9
1906,[1]	.35	6.70	2.59	.0036	.0231	.0188	.0043	.19	.0026	.0001	.77	3.2
1907,[2]	.35	5.58	1.89	.0027	.0200	.0144	.0056	.19	.0048	.0002	.66	2.5
1908,[3]	.30	8.04	2.78	.0071	.0196	.0143	.0053	.29	.0030	.0001	.80	-
1909, ...	.33	8.66	2.92	.0036	.0196	.0140	.0056	.22	.0020	.0001	.89	-
1910, ...	.36	8.80	3.15	.0042	.0183	.0143	.0040	.21	.0035	.0002	.76	-

[1] November omitted. [2] June and July omitted. [3] June omitted.

CONNECTICUT RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONNECTICUT RIVER, ETC. — *Concluded.*

Connecticut River, below Springfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1888,	.35	5.34	1.24	.0032	.0182	.0143	.0039	.15	.0082	.0002	–	–
1899,	.33	6.61	1.99	.0093	.0238	.0195	.0043	.23	.0042	.0003	.67	3.1
1900,	.44	6.64	1.90	.0098	.0250	.0176	.0074	.20	.0034	.0002	.89	3.1
1901,	.32	6.03	2.34	.0061	.0190	.0153	.0037	.18	.0048	.0003	.65	3.0
1902,	.31	5.83	2.13	.0062	.0180	.0140	.0040	.16	.0055	.0005	.61	3.0
1903,	.30	6.12	2.04	.0098	.0202	.0147	.0055	.24	.0058	.0004	.61	2.7
1904,[1]	.22	5.22	1.87	.0098	.0187	.0125	.0062	.21	.0047	.0002	.48	2.4
1906,[2]	.35	7.14	2.61	.0082	.0204	.0161	.0043	.24	.0026	.0004	.71	2.8
1907,[3]	.38	6.27	2.46	.0069	.0163	.0131	.0032	.24	.0050	.0003	.67	2.9
1908,	.32	8.58	2.61	.0214	.0223	.0165	.0058	.38	.0040	.0004	.81	–
1909,	.29	6.02	2.25	.0079	.0156	.0118	.0038	.22	.0018	.0003	.65	–
1910,	.33	8.67	3.60	.0155	.0241	.0188	.0053	.37	.0028	.0003	.89	–

[1] Three months. [2] June omitted. [3] June and July omitted.

DEERFIELD RIVER.

This river receives very little pollution throughout most of its course except near the lower part of its watershed. It receives a small quantity of sewage from the village of Shelburne Falls, about 16 miles from its mouth, but the most serious pollution is caused by the discharge of the sewage of the town of Greenfield into the Green River, one of the tributaries of the Deerfield, close to the latter stream.

DEERFIELD RIVER.

CHEMICAL EXAMINATION OF WATER FROM DEERFIELD RIVER AND TRIBUTARY. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Deerfield River, at Deerfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1901,[1]	.23	4.35	1.58	.0011	.0121	.0109	.0012	.10	.0080	.0001	.38	2.1
1903,[2]	.21	4.15	1.47	.0012	.0106	.0093	.0013	.10	.0088	.0001	.34	1.9
1904,	.31	4.29	1.52	.0021	.0144	.0115	.0029	.11	.0040	.0001	.47	1.9

[1] Three months. [2] June omitted.

CHEMICAL EXAMINATION OF WATER FROM DEERFIELD RIVER AND TRIBUTARY, ETC. — *Concluded.*

Green River, below Greenfield.

[Parts in 100,000.]

YEAR.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1903, ...	.05	7.75	2.23	.0152	.0143	.0086	.0057	.21	.0078	.0005	.15	3.9
1904, ...	.07	6.93	2.01	.0151	.0382	.0138	.0244	.28	.0100	.0006	.22	3.8
1905, ...	.17	11.06	2.97	.0665	.0337	.0131	.0206	.45	.0043	.0011	.33	-
1909, ...	.14	7.82	2.54	.0459	.0333	.0151	.0182	.37	.0038	.0011	.23	-
1910, ...	.17	8.33	3.16	.0775	.0284	.0169	.0115	.37	.0025	.0012	.23	-

FRENCH RIVER.

The French River is very badly polluted at several points along its course, the most serious pollution being at Webster, where in addition to the sewage from the town it receives the wastes from a very large woolen mill.

CHEMICAL EXAMINATION OF WATER FROM FRENCH RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

French River, below Webster.

[Parts in 100,000.]

YEAR.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899, ...	.44	5.67	2.07	.0238	.0612	.0384	.0228	.42	.0024	.0007	.66	1.6
1900, ...	.52	5.79	2.10	.0202	.0475	.0357	.0118	.46	.0062	.0007	.78	1.5
1901, ...	.50	5.29	2.25	.0090	.0390	.0265	.0125	.33	.0044	.0002	.75	1.2
1902, ...	.42	4.92	1.99	.0057	.0391	.0264	.0127	.39	.0038	.0002	.65	1.2
1903, ...	.48	4.67	1.88	.0049	.0352	.0241	.0111	.40	.0058	.0002	.72	0.9
1904, ...	.44	6.02	2.18	.0267	.0434	.0281	.0153	.58	.0042	.0004	.70	1.3
1906, ...	.61	5.08	2.19	.0063	.0353	.0246	.0107	.40	.0038	.0003	.81	0.9
1907,[1]	.54	6.28	2.62	.0117	.0544	.0304	.0240	.49	.0035	.0004	.69	1.2
1908, ...	.44	7.17	2.82	.0086	.0507	.0310	.0197	.61	.0037	.0010	.81	-
1909, ...	.50	7.42	2.61	.0267	.0638	.0385	.0253	.77	.0055	.0012	.72	-
1910, ...	.44	8.27	3.55	.0512	.0527	.0321	.0206	.78	.0016	.0021	.79	-

[1] June and July omitted.

Hoosick River.

The Hoosick River is polluted seriously by sewage discharged into the stream at Adams in the watershed of the south branch, and by small quantities of sewage and manufacturing wastes discharged into the north branch. Its most serious pollution, however, is that caused by the sewage and manufacturing wastes discharged at North Adams, which grossly pollute the stream for many miles. The sewage of Williamstown is also discharged directly into the stream near the point where it flows into the State of Vermont.

HOOSICK RIVER.

Chemical Examination of Water from Hoosick River. — Averages for Six Months, from June to November, inclusive.

Hoosick River, at Williamstown.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887, . . .	.22	12.05	1.22	.0065	.0190	–	–	.23	.0232	–	–	–
1888, . . .	.12	10.82	1.90	.0026	.0210	.0142	.0068	.27	.0247	.0015	–	–
1894, . . .	.37	13.56	2.74	.0166	.0361	.0224	.0137	.50	.0102	.0014	.42	9.0
1895, . . .	.34	14.20	3.26	.0190	.0424	.0241	.0183	.63	.0090	.0020	.53	9.0
1896, . . .	.21	11.71	2.39	.0295	.0267	.0172	.0095	.39	.0133	.0018	.33	8.6
1897, . . .	.26	11.32	2.39	.0174	.0312	.0173	.0139	.30	.0265	.0011	.31	7.9
1898, . . .	.27	10.46	2.38	.0223	.0311	.0210	.0101	.31	.0170	.0007	.34	6.6
1899, . . .	.30	15.21	3.31	.0252	.0622	.0379	.0243	.64	.0070	.0029	.62	8.3
1900, . . .	.28	14.20	2.79	.0433	.0547	.0301	.0246	.60	.0087	.0043	.58	7.8
1901, . . .	.27	13.02	3.70	.0400	.0520	.0250	.0270	.43	.0152	.0024	.53	7.3
1902, . . .	.22	10.62	2.87	.0069	.0307	.0172	.0135	.34	.0123	.0014	.40	6.4
1903, . . .	.17	10.50	2.37	.0272	.0264	.0151	.0113	.29	.0183	.0019	.33	7.5
1904, . . .	.13	12.30	3.23	.0677	.0310	.0191	.0119	.45	.0203	.0024	.29	8.3
1905, . . .	.20	11.09	2.81	.0295	.0265	.0156	.0109	.32	.0123	.0015	.31	5.6
1906, . . .	.31	13.28	3.63	.0415	.0489	.0252	.0237	.47	.0147	.0030	.43	6.0
1907, . . .	.25	11.80	2.93	.0431	.0390	.0231	.0159	.47	.0135	.0021	.39	7.9
1908, . . .	.23	14.00	3.86	.0559	.0323	.0195	.0128	.54	.0085	.0023	.37	–
1909, . . .	.23	15.46	4.09	.0496	.0382	.0243	.0139	.62	.0060	.0035	.41	–
1910, . . .	.30	13.06	4.43	.0320	.0336	.0219	.0117	.52	.0102	.0018	.41	–

Housatonic River.

The branches of this stream in and about Pittsfield on the whole show some improvement over previous years, but below the city the evidences of pollution are more serious. The sewage of Dalton is discharged directly into the stream above Pittsfield and the sewage of the towns of Lee and Great Barrington is also discharged directly into the stream in the lower part of its watershed in Massachusetts. At Pittsfield, Lenox and Stockbridge purification works have been constructed, at which the sewage is treated before being discharged into the stream.

HOUSATONIC RIVER.

CHEMICAL EXAMINATION OF WATER FROM HOUSATONIC RIVER AND ITS BRANCHES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

East Branch, below Pittsfield.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1903, ...	.32	9.75	2.92	.0118	.0226	.0153	.0073	.25	.0142	.0006	.56	6.8
1904,[1]	.28	9.02	3.15	.0117	.0248	.0175	.0073	.26	.0113	.0005	.47	6.2
1907,[2]	.42	9.40	3.00	.0286	.0284	.0186	.0098	.28	.0060	.0010	.50	6.4
1908,[3]	.29	12.76	3.57	.0327	.0250	.0177	.0073	.40	.0140	.0011	.47	–
1909, ...	.26	12.60	4.37	.0431	.0305	.0215	.0090	.33	.0087	.0007	.44	–
1910, ...	.30	12.98	5.26	.0437	.0233	.0182	.0051	.40	.0080	.0012	.48	–

[1] Three months. [2] Two months. [3] November omitted.

West Branch, below Pittsfield.

1903, ...	.29	10.43	2.83	.0100	.0210	.0143	.0067	.23	.0143	.0006	.46	7.4
1904,[1]	.15	12.27	3.50	.0137	.0423	.0217	.0206	.35	.0050	.0004	.35	7.8
1908,[2]	.20	13.28	3.68	.0210	.0301	.0194	.0107	.26	.0026	.0009	.36	–
1909, ...	–	11.00	2.87	.0070	.0283	.0175	.0108	.24	.0010	.0003	.25	–
1910, ...	.22	13.85	4.98	.0218	.0446	.0218	.0228	.40	.0012	.0011	.40	–

[1] Three months. [2] November omitted.

South-west Branch, at Pittsfield.

1899, ...	.17	14.92	2.58	.0040	.0353	.0211	.0142	.16	.0108	.0004	.37	9.2
1900, ...	.14	14.87	2.15	.0192	.0335	.0229	.0106	.21	.0107	.0008	.35	10.2
1901, ...	.14	13.20	3.87	.0051	.0302	.0197	.0105	.16	.0096	.0004	.41	9.4
1902, ...	.11	12.30	3.09	.0057	.0224	.0136	.0088	.12	.0108	.0005	.37	8.7
1903, ...	.10	11.63	2.37	.0045	.0162	.0109	.0053	.11	.0115	.0003	.25	8.8
1904,[1]	.15	12.45	3.63	.0116	.0455	.0223	.0232	.34	.0040	.0018	.35	7.8
1907,[2]	.31	10.78	2.30	.0040	.0258	.0168	.0090	.20	.0025	.0003	.39	8.2
1908,[3]	.18	15.17	4.89	.0216	.0269	.0159	.0110	.23	.0036	.0007	.33	–
1909, ...	.17	14.82	4.41	.0041	.0265	.0153	.0112	.23	.0032	.0005	.37	–
1910, ...	.17	14.45	5.25	.0049	.0196	.0135	.0061	17	.0045	.0006	.30	–

[1] Three months. [2] Two months. [3] November omitted.

Housatonic River, below Great Barrington.

1908, ...	.18	14.97	3.69	.0106	.0269	.0172	.0097	.43	.0107	.0011	.36	–
1909, ...	.16	14.91	4.41	.0067	.0247	.0173	.0074	.47	.0078	.0012	.35	–
1910, ...	.22	14.97	5.32	.0128	.0233	.0181	.0052	.51	.0090	.0021	.34	–

MERRIMACK RIVER.

The Merrimack River receives considerable pollution from cities and towns beyond the limits of the State and a large amount of pollution by sewage and manufacturing wastes in cities and towns along its banks in Massachusetts.

MERRIMACK RIVER.

CHEMICAL EXAMINATION OF WATER FROM MERRIMACK RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Merrimack River, above Lowell.

[Parts in 100,000.]

YEAR.		RESIDUE ON EVAPORATION.		AMMONIA.					NITROGEN AS			
					ALBUMINOID.							
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
1887, . . .	.45	4.08	1.10	.0024	.0156	-	-	.17	.0078	-	-	-
1888, . . .	.32	3.47	1.01	.0014	.0161	.0137	.0024	.16	.0062	.0002	-	-
1889, . . .	.37	-	-	.0028	.0166	.0143	.0023	.17	.0067	.0001	-	-
1890, . . .	.34	3.85	1.58	.0025	.0148	.0123	.0025	.14	.0106	.0002	-	1.4
1891, . . .	.27	3.73	1.47	.0029	.0147	.0111	.0036	.17	.0080	.0002	-	1.4
1892, . . .	.39	3.75	1.37	.0028	.0139	.0106	.0033	.15	.0097	.0002	-	1.6
1893, . . .	.25	3.47	1.13	.0028	.0141	.0110	.0031	.17	.0072	.0001	.38	1.1
1894, . . .	.29	3.86	1.32	.0037	.0140	.0114	.0026	.19	.0042	.0001	.36	1.2
1895, . . .	.43	3.97	1.61	.0019	.0197	.0151	.0046	.24	.0054	.0001	.55	1.2
1896, . . .	.44	3.85	1.41	.0049	.0181	.0149	.0032	.18	.0063	.0002	.66	1.0
1897, . . .	.54	3.62	1.68	.0030	.0181	.0148	.0033	.16	.0077	.0001	.52	0.9
1898, . . .	.39	3.93	1.74	.0032	.0197	.0171	.0026	.19	.0047	.0001	.51	1.0
1899, . . .	.20	3.88	1.45	.0050	.0205	.0166	.0039	.22	.0055	.0002	.38	1.2
1900, . . .	.23	3.72	1.21	.0068	.0215	.0158	.0057	.23	.0038	.0002	.44	1.3
1901, . . .	.38	4.32	1.98	.0060	.0208	.0172	.0036	.20	.0042	.0002	.69	1.2
1902, . . .	.38	3.81	1.59	.0056	.0163	.0142	.0021	.17	.0043	.0001	.64	0.9
1903, . . .	.30	4.00	1.55	.0058	.0171	.0129	.0042	.23	.0040	.0002	.59	1.1
1904, . . .	.33	4.61	1.92	.0077	.0194	.0153	.0041	.23	.0047	.0002	.69	1.3
1905, . . .	.40	4.30	1.95	.0112	.0202	.0160	.0042	.25	.0038	.0002	.71	1.1
1906, . . .	.37	4.64	1.84	.0100	.0201	.0174	.0027	.26	.0032	.0002	.71	1.2
1907, . . .	.38	4.60	1.88	.0079	.0194	.0135	.0059	.28	.0043	.0002	.63	1.2
1908, . . .	.29	4.67	1.80	.0125	.0195	.0141	.0054	.36	.0048	.0003	.64	1.3
1909, . . .	.31	5.16	2.38	.0185	.0213	.0161	.0052	.36	.0018	.0002	.68	1.5
1910, . . .	.37	5.11	1.78	.0242	.0221	.0180	.0041	.35	.0035	.0007	.68	1.4

CHEMICAL EXAMINATION OF WATER FROM MERRIMACK RIVER, ETC. — *Concluded.*

Merrimack River, above Lawrence.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887, ...	.47	4.82	1.24	.0027	.0211	-	-	.22	.0097	-	-	-
1888, ...	.32	3.64	1.18	.0029	.0197	.0153	.0044	.18	.0074	.0003	-	-
1889, ...	.35	-	-	.0047	.0212	.0176	.0036	.20	.0053	.0002	-	-
1890, ...	.37	4.27	1.56	.0061	.0187	.0148	.0039	.19	.0068	.0002	-	1.6
1891, ...	.21	4.06	1.37	.0066	.0179	.0138	.0041	.21	.0090	.0002	-	1.4
1892, ...	.46	4.25	1.50	.0054	.0186	.0155	.0031	.19	.0087	.0002	-	1.5
1893, ...	.40	4.25	1.62	.0084	.0172	.0138	.0034	.23	.0057	.0003	.52	1.3
1894, ...	.32	3.82	1.35	.0086	.0174	.0142	.0032	.25	.0043	.0001	.40	1.3
1895, ...	.52	4.45	1.97	.0068	.0251	.0194	.0057	.30	.0067	.0003	.60	1.5
1896, ...	.46	4.24	1.70	.0100	.0224	.0181	.0043	.25	.0067	.0005	.57	1.3
1897, ...	.58	4.06	1.67	.0061	.0222	.0190	.0032	.21	.0053	.0002	.53	1.0
1898, ...	.44	4.46	1.87	.0076	.0262	.0208	.0054	.25	.0050	.0005	.59	1.3
1899, ...	.24	4.42	1.57	.0138	.0277	.0207	.0070	.32	.0052	.0004	.43	1.3
1900, ...	.27	4.22	1.35	.0126	.0249	.0190	.0059	.32	.0050	.0003	.46	1.3
1901, ...	.44	4.73	1.90	.0100	.0280	.0205	.0075	.28	.0070	.0006	.65	1.5
1902, ...	.42	4.40	1.85	.0110	.0231	.0180	.0051	.26	.0038	.0003	.65	1.1
1903, ...	.37	4.66	1.73	.0111	.0226	.0166	.0060	.31	.0052	.0005	.64	1.4
1904, ...	.31	4.67	1.80	.0211	.0247	.0170	.0077	.33	.0053	.0004	.62	1.4
1905, ...	.44	4.92	2.01	.0177	.0242	.0183	.0059	.38	.0040	.0005	.74	1.2
1906, ...	.39	5.30	2.12	.0170	.0263	.0215	.0048	.40	.0027	.0005	.72	1.4
1907, ...	.40	4.92	1.80	.0293	.0253	.0175	.0078	.41	.0047	.0005	.59	1.3
1908, ...	.33	5.61	2.19	.0354	.0303	.0196	.0107	.57	.0052	.0006	.74	1.5
1909, ...	.33	6.28	2.04	.0336	.0262	.0196	.0066	.53	.0025	.0007	.67	1.7
1910, ...	.39	-	-	.0266	.0242	.0183	.0059	.53	.0125	.0006	.57	1.6

MILLER'S RIVER.

This river receives the direct discharge of sewage from the towns of Athol and Orange beside considerable untreated sewage and small quantities of manufacturing wastes at various points in its course. It is not seriously polluted except for short distances in the immediate neighborhood of sewer outlets. Analyses of the river above the point where it joins the Connecticut River follow.

MILLER'S RIVER.

CHEMICAL EXAMINATION OF WATER FROM MILLER'S RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Miller's River, below Miller's Falls.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908, ...	.54	4.59	2.06	.0054	.0233	.0181	.0052	.34	.0060	.0002	.64	–
1909, ...	.54	4.38	1.84	.0035	.0207	.0181	.0026	.34	.0030	.0002	.60	–
1910, ...	.55	5.48	2.28	.0068	.0231	.0202	.0029	.44	.0075	.0002	.68	–

NASHUA RIVER.

One of the most seriously polluted streams in the State is the north branch of the Nashua River, which is polluted by sewage and great quantities of manufacturing wastes of various kinds in the city of Fitchburg and town of Leominster. Its condition improves somewhat in the lower part of its course but it is still badly polluted above the point where it flows out of the State.

NASHUA RIVER.

CHEMICAL EXAMINATION OF WATER FROM NASHUA RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

North Branch of Nashua River, below Fitchburg.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1893, ...	.70	8.32	2.38	.0562	.0405	.0289	.0116	.73	.0097	.0030	.73	2.2
1894, ...	.66	9.18	2.22	.0987	.0425	.0308	.0117	.99	.0123	.0034	.64	2.4
1895, ...	.71	9.42	2.72	.1387	.0493	.0381	.0112	1.08	.0068	.0014	.82	2.6
1896, ...	.57	9.27	2.62	.0898	.0537	.0384	.0153	.95	.0127	.0030	.71	2.4
1897, ...	.67	7.62	2.50	.0512	.0518	.0389	.0129	.71	.0112	.0009	.79	2.1
1898, ...	.56	7.02	2.37	.0688	.0629	.0399	.0230	.56	.0097	.0016	.72	1.8
1899, ...	.53	10.12	2.95	.1507	.0848	.0537	.0311	1.03	.0055	.0018	.83	2.4

NASHUA RIVER.

CHEMICAL EXAMINATION OF WATER FROM NASHUA RIVER, ETC. — *Concluded.*

North Branch of Nashua River, below Fitchburg — Concluded.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1900, ...	.42	9.55	2.42	.1575	.0825	.0479	.0346	1.03	.0060	.0015	.73	2.6
1901, ...	.42	8.45	2.58	.0964	.0508	.0347	.0161	.67	.0080	.0013	.69	2.2
1902, ...	.39	7.83	2.42	.1070	.0557	.0407	.0150	.68	.0072	.0012	.71	1.9
1903, ...	.38	7.21	2.10	.1200	.0471	.0281	.0190	.73	.0095	.0014	.62	1.7
1904, ...	.33	9.05	2.70	.1858	.0596	.0341	.0255	.88	.0077	.0015	.70	2.1
1905, ...	.48	7.66	2.33	.1284	.0568	.0354	.0214	.73	.0053	.0008	.89	2.1
1906, ...	.47	7.68	2.16	.1037	.0558	.0356	.0202	.75	.0083	.0020	.68	2.0
1907, ...	.50	10.77	2.72	.2180	.0654	.0350	.0304	1.24	.0065	.0012	.72	2.8
1908, ...	.52	15.05	3.60	.2605	.0861	.0494	.0367	1.58	.0033	.0016	1.04	–
1909, ...	.52	15.85	3.42	.3220	.0958	.0563	.0395	1.87	.0027	.0014	1.02	–
1910, ...	.60	20.11	4.90	.4047	.1235	.0789	.0446	2.29	.0017	.0009	1.03	–

North Branch of Nashua River, at Lancaster.

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1892, ...	.48	9.75	2.10	.0422	.0274	.0237	.0037	1.11	.0450	.0010	–	3.0
1894, ...	.49	8.07	1.97	.0215	.0226	.0182	.0044	.97	.0295	.0011	.49	2.2
1895, ...	.51	8.28	2.39	.0318	.0272	.0214	.0058	1.01	.0284	.0034	.56	2.3
1896, ...	.57	6.97	2.17	.0253	.0322	.0253	.0069	.66	.0167	.0034	.60	2.0
1897, ...	.65	5.45	2.03	.0225	.0290	.0221	.0069	.40	.0153	.0015	.68	1.5
1898, ...	.48	6.33	2.10	.0409	.0345	.0263	.0082	.56	.0227	.0033	.51	1.7
1899, ...	.39	7.60	2.33	.0739	.0365	.0305	.0060	.75	.0153	.0028	.60	2.0
1900, ...	.29	7.17	1.55	.0545	.0326	.0264	.0062	.81	.0202	.0039	.52	2.1
1901, ...	.37	6.72	2.14	.0432	.0329	.0240	.0089	.54	.0087	.0021	.58	1.9
1902, ...	.40	7.96	2.66	.0757	.0324	.0267	.0057	.70	.0188	.0043	.58	1.8
1903, ...	.36	6.95	2.35	.0473	.0260	.0201	.0059	.58	.0258	.0034	.52	1.6
1904, ...	.32	8.01	2.18	.0803	.0318	.0267	.0051	.80	.0267	.0040	.53	2.0
1905, ...	.34	7.20	2.13	.0616	.0296	.0227	.0069	.70	.0207	.0044	.50	1.9
1906, ...	.44	7.34	2.12	.0519	.0311	.0240	.0071	.72	.0238	.0027	.56	2.0
1907, ...	.44	8.34	2.33	.0600	.0294	.0232	.0062	.89	.0333	.0084	.53	2.1
1908, ...	.40	10.69	2.78	.1075	.0309	.0259	.0050	1.28	.0405	.0090	.58	–
1909, ...	.44	12.26	3.41	.1556	.0330	.0284	.0046	1.46	.0360	.0066	.60	–
1910, ...	.45	13.44	3.82	.1655	.0462	.0366	.0096	1.63	.0388	.0108	.70	–

Nashua River, at Pepperell.

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1900, ...	.28	6.91	2.19	.0167	.0248	.0221	.0027	.78	.0137	.0008	.46	2.1
1901, ...	.37	6.00	2.06	.0154	.0266	.0230	.0036	.45	.0092	.0005	.55	1.9
1902, ...	.37	5.81	2.07	.0118	.0184	.0167	.0017	.49	.0162	.0006	.51	1.7
1903, ...	.35	5.15	1.57	.0097	.0180	.0152	.0028	.44	.0128	.0008	.55	1.6
1904,[1]	.30	6.23	1.93	.0111	.0206	.0171	.0035	.58	.0243	.0008	.44	1.9
1908, ...	.32	10.85	3.40	.0317	.0295	.0202	.0093	1.45	.0194	.0008	.63	–
1909, ...	.38	14.29	4.62	.0354	.0376	.0291	.0085	1.95	.0211	.0017	.92	–
1910, ...	.37	14.77	4.14	.0128	.0329	.0252	.0077	1.93	.0207	.0008	.81	–

[1] Three months.

NEPONSET RIVER.

This stream is badly polluted by manufacturing wastes, though at nearly all of the factories and mills discharging manufacturing wastes into this stream works for the treatment or purification of the wastes have either been established or are at present under construction. Analyses of the water of the river at Hyde Park, in the lower part of its course, are appended.

NEPONSET RIVER.

CHEMICAL EXAMINATION OF WATER FROM NEPONSET RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Neponset River, at Hyde Park.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887, . . .	1.18	8.20	2.22	.0053	.0402	–	–	.98	.0077	–	–	–
1888, . . .	1.12	7.77	2.37	.0040	.0392	.0358	.0034	1.08	.0074	.0003	–	–
1893, . . .	1.27	8.60	2.68	.0233	.0370	.0282	.0088	1.47	.0045	.0009	1.00	2.6
1894, . . .	1.19	12.87	3.03	.0196	.0466	.0333	.0133	2.31	.0033	.0002	1.03	4.1
1895, . . .	.97	10.01	3.07	.0341	.0440	.0373	.0067	1.51	.0042	.0001	1.05	3.7
1896, . . .	1.26	10.41	3.12	.0162	.0431	.0395	.0036	1.68	.0033	.0001	1.26	3.3
1897, . . .	1.30	11.64	3.34	.0336	.0494	.0417	.0077	1.81	.0037	.0001	1.31	4.0
1898, . . .	1.28	8.82	3.52	.0161	.0505	.0398	.0107	1.02	.0023	.0002	1.30	2.7
1899, . . .	1.14	16.24	4.51	.0264	.0936	.0693	.0243	2.20	.0032	.0002	1.76	5.7
1900, . . .	1.10	10.59	2.99	.0400	.0576	.0381	.0195	1.45	.0048	.0005	1.07	3.2
1901, . . .	1.43	13.26	5.09	.0224	.0802	.0591	.0211	1.69	.0036	.0006	1.82	4.2
1902, . . .	1.02	12.57	4.19	.0360	.0640	.0547	.0093	1.72	.0035	.0004	1.29	4.0
1903, . . .	1.29	14.21	4.95	.0278	.0811	.0638	.0173	1.86	.0034	.0010	1.71	4.5
1904, . . .	1.08	16.22	5.68	.0631	.1007	.0777	.0230	2.07	.0037	.0005	1.67	5.6
1905, . . .	1.22	21.88	6.68	.0813	.1043	.0861	.0182	3.44	.0028	.0006	2.22	6.6
1906, . . .	1.35	13.47	4.42	.0549	.0875	.0674	.0201	2.21	.0025	.0008	1.85	3.9
1907, . . .	.90	22.58	6.31	.1201	.1412	.0961	.0451	3.81	.0042	.0004	1.94	6.9
1908, . . .	–	25.40	7.19	.1132	.1209	.0844	.0365	5.08	.0027	.0006	3.01	8.8
1909, . . .	–	28.69	9.08	.1723	.1218	.0898	.0320	5.35	.0027	.0009	2.02	10.0
1910, . . .	–	31.37	10.16	.1740	.1333	.1000	.0333	5.84	.0010	.0002	2.96	10.4

QUINEBAUG RIVER.

The largest town in the valley of the Quinebaug River in Massachusetts is Southbridge, the sewage of which is filtered before being discharged into the stream. The river still receives considerable quantities of manufacturing wastes and small quantities of sewage, but its condition at the point where it leaves the State is not objectionable.

QUINEBAUG RIVER.

CHEMICAL EXAMINATION OF WATER FROM QUINEBAUG RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Quinebaug River, below Southbridge.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1898, ...	.64	4.18	2.00	.0064	.0372	.0309	.0063	.18	.0050	.0003	.66	0.8
1899, ...	.44	4.32	1.72	.0071	.0298	.0229	.0069	.23	.0048	.0002	.54	1.2
1900, ...	.40	4.31	1.56	.0168	.0324	.0211	.0113	.25	.0024	.0003	.52	1.0
1901, ...	.42	4.53	1.67	.0147	.0232	.0158	.0074	.19	.0050	.0005	.45	1.7
1902, ...	.36	4.12	1.45	.0068	.0224	.0179	.0045	.24	.0054	.0002	.43	1.2
1903,[1]	.39	3.84	1.37	.0076	.0225	.0181	.0044	.24	.0043	.0002	.52	1.0
1904, ...	.40	4.17	1.57	.0086	.0247	.0189	.0058	.26	.0068	.0002	.53	1.2
1908, ...	.46	6.83	2.31	.0075	.0277	.0174	.0103	.33	.0038	.0003	.57	-
1909, ...	.40	5.48	1.99	.0087	.0275	.0219	.0056	.37	.0077	.0003	.56	-
1910, ...	.40	6.20	2.27	.0104	.0334	.0246	.0088	.42	.0032	.0004	.53	-

[1] June and July omitted.

TAUNTON RIVER.

The Taunton River and its tributaries are polluted considerably by sewage, chiefly from the town of Middleborough, where the sewers discharge into the Nemasket River, and from Taunton, where the sewage of the city is discharged into the stream near the head of tide water.

TAUNTON RIVER.

CHEMICAL EXAMINATION OF WATER FROM TAUNTON RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Taunton River, below Taunton.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1898, ...	1.56	6.64	3.30	.0109	.0345	.0314	.0031	.61	.0082	.0003	1.51	1.3
1899, ...	.93	6.31	2.48	.0176	.0317	.0279	.0038	.72	.0060	.0004	1.04	1.2
1900, ...	.71	6.89	1.91	.0205	.0286	.0258	.0028	1.06	.0112	.0006	.76	1.5
1901, ...	1.01	6.15	2.45	.0293	.0275	.0255	.0020	.76	.0134	.0005	.92	1.6
1902,[1]	.94	6.92	2.36	.1902	.0363	.0308	.0055	1.29	.0116	.0012	.90	1.4
1903, ...	.96	7.06	2.60	.0542	.0270	.0234	.0036	1.10	.0177	.0013	1.02	1.7
1904, ...	.95	6.49	2.60	.0555	.0319	.0264	.0055	.94	.0137	.0008	1.06	1.3
1906,[2]	1.41	7.37	3.11	.0401	.0385	.0331	.0054	.95	.0162	.0008	1.36	1.4
1907,[3]	.94	7.16	2.62	.1031	.0343	.0282	.0061	1.05	.0115	.0009	1.05	1.7
1908, ...	.78	7.66	2.52	.0469	.0278	.0226	.0052	1.31	.0108	.0011	.74	-
1909, ...	.90	12.97	3.87	.0416	.0303	.0263	.0040	3.49	.0105	.0014	.88	-
1910, ...	1.04	19.62	5.69	.0658	.0376	.0305	.0071	6.82	.0110	.0027	.93	-

[1] September omitted. [2] June omitted. [3] June and July omitted.

TEN MILE RIVER.

The Ten Mile River is badly polluted by sewage at North Attleborough and Attleborough, but works for the purification of the sewage of these towns are now under construction which will provide for the removal of the sewage discharged into the stream at these places within a few months.

TEN MILE RIVER.

CHEMICAL EXAMINATION OF WATER FROM TEN MILE RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Ten Mile River, below Attleborough.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899, . . .	.71	6.39	2.15	.0072	.0379	.0288	.0091	.62	.0133	.0004	.74	1.7
1900, . . .	.47	6.19	1.60	.0125	.0363	.0241	.0122	.84	.0155	.0004	.49	1.8
1901, . . .	.46	6.09	2.12	.0084	.0290	.0202	.0088	.71	.0222	.0004	.51	1.8
1902, . . .	.41	6.49	1.83	.0073	.0394	.0237	.0157	.88	.0212	.0004	.52	1.9
1903, . . .	.36	7.48	2.39	.0282	.0346	.0200	.0146	.84	.0315	.0020	.53	1.8
1904, . . .	.44	8.89	2.97	.0931	.0527	.0332	.0195	1.03	.0532	.0033	.58	3.5
1906,[1] . . .	.48	17.57	6.45	.1586	.0914	.0490	.0424	1.07	.0638	.0121	.92	7.9
1907,[1] . . .	.42	19.07	6.14	.6036	.1471	.0830	.0641	1.73	.2014	.0100	1.18	7.5
1908, . . .	.40	10.89	3.27	.1108	.0483	.0294	.0189	1.37	.0364	.0035	.61	-
1909, . . .	.47	11.23	2.88	.4322	.0626	.0380	.0246	1.51	.0263	.0086	.78	-
1910, . . .	.29	12.05	3.32	.2422	.0545	.0330	.0215	1.98	.0357	.0051	.48	-

[1] June omitted.

WESTFIELD RIVER.

The chief pollutions of the Westfield River are those caused by the sewage discharged from the town of Westfield and smaller quantities of sewage from West Springfield and Agawam. It also receives a comparatively small amount of pollution from manufacturing wastes at several points along its course.

WESTFIELD RIVER.

CHEMICAL EXAMINATION OF WATER FROM WESTFIELD RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Westfield River, below Westfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1902, . . .	.22	4.21	1.60	.0062	.0144	.0118	.0026	.14	.0062	.0002	.39	1.9
1903, . . .	.15	3.68	1.30	.0037	.0127	.0105	.0022	.16	.0088	.0003	.28	1.8
1904, . . .	.21	4.16	1.59	.0067	.0152	.0119	.0033	.16	.0068	.0001	.38	1.9
1906,[1] . . .	.21	4.65	1.48	.0086	.0161	.0135	.0026	.18	.0035	.0003	.29	2.1
1907, . . .	.24	4.49	1.63	.0053	.0137	.0111	.0026	.21	.0075	.0003	.31	2.0
1908, . . .	.17	5.27	2.19	.0218	.0161	.0116	.0045	.27	.0063	.0006	.28	-
1909, . . .	.22	5.56	1.68	.0179	.0187	.0143	.0044	.26	.0075	.0005	.34	-
1910, . . .	.13	6.71	2.39	.0214	.0143	.0120	.0023	.30	.0304	.0010	.21	-

[1] June and July omitted.

WATER SUPPLY STATISTICS;

ALSO

RECORDS OF RAINFALL AND FLOW OF STREAMS.

WATER SUPPLY STATISTICS.

During the year 1910 water supplies were introduced into the towns of Douglas (population 2,152), Dudley (population 4,267) and Granville (population 781). The works in Douglas and Dudley are owned by the town and in Granville by the Granville Center Water Company.

Of the 354 cities and towns in Massachusetts, all of the 33 cities and 159 of the towns are provided with public water supplies. The following table gives the classification by population of the cities and towns having and not having public water supplies at the end of the year: —

POPULATION, 1910.	Number of Places of Given Population having Public Water Supplies.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having Public Water Supplies.	Total Population of Places in Preceding Column.
Under 500,	-	-	39	13,020
500-999,	4	3,399	43	31,483
1,000-1,499,	17	20,950	33	40,818
1,500-1,999,	11	19,563	22	38,528
2,000-2,499,	19	42,216	14	31,077
2,500-2,999,	10	28,094	4	10,966
3,000-3,499,	8	26,167	1	3,078
3,500-3,999,	5	18,164	2	7,506
Above 4,000,	118	3,012,502	4	18,890
Totals,	192	3,171,055	162	195,361

From the above table it will be seen that although but 54 per cent. of the cities and towns in the State have a public water supply, the total population of the places supplied is 94 per cent. of the total population of the State. The populations given in this table were obtained by using the total population of the cities and towns supplied, and is somewhat greater than the actual number of persons to whom the public water supply is available, but the difference is not great. All of the towns, except Blackstone, having a population in excess of 5,000 are supplied with water, and there are only 11 towns in the State having a population in excess of 2,500 which are not provided with public water supplies. These towns are as follows: —

TOWN.	Population, 1910.	TOWN.	Population, 1910.
Blackstone,	5,648	Sutton,	3,078
Barnstable,	4,676	Westport,	2,928
Dartmouth,	4,378	Somerset,	2,798
Warren,	4,188	Medway,[1]	2,696
Templeton,	3,756	Norton,	2,544
Tewksbury,	3,750		

[1] Works under construction.

At the present time the water works are owned either by the municipality or by a fire or water supply district in all of the cities and 118 of the towns, while in 41 towns the works are owned by private companies. The following table gives the classification by population of the cities and towns which own their water works and those which are supplied with water by water companies: —

POPULATION, 1910.	Number of Places of Given Population owning Water Works.	Total Population of Places in Preceding Column.	Number of Places of Given Population supplied with Water by Private Companies.	Total Population of Places in Preceding Column.
Under 1,000,	1	717	3	2,682
1,000–1,999,	19	27,282	9	13,231
2,000–2,999,	19	45,210	10	25,100
3,000–3,999,	6	20,348	7	23,983
4,000–4,999,	12	55,128	3	13,811
5,000–5,999,	15	81,865	3	15,939
6,000–6,999,	8	52,608	–	–
7,000–7,999,	5	36,945	1	7,688
Above 8,000,	66	2,696,170	5	52,348
Total,	151	3,016,273	41	154,782

The tendency towards municipal ownership of water supplies is shown in the following table giving, for census years since 1890, the total population of all cities and towns supplied with water, the population of those places supplied by private companies and its percentage of the total population of all places supplied: —

Year.	Total Population of All Places supplied with Water.	Population of Places supplied by Private Companies.	Per Cent. Preceding Column is of All Places supplied.
1890,	1,924,812	318,319	16.5
1895,	2,237,017	212,579	9.5
1900,	2,565,301	236,869	9.2
1905,	2,792,490	193,290	6.9
1910,	3,171,055	154,782	4.9

From the above table it will be seen that the total population of all places supplied by private companies is only 4.9 per cent. of the total population of all of the cities and towns supplied with water, and there are only 9 towns having a population in excess of 5,000 which are supplied by private companies, namely, Milford, Southbridge, Dedham, Northbridge, Palmer, Bridgewater, Grafton, Fairhaven and Amherst.

The population and valuation of all of the cities and towns in Massachusetts in 1910 is given in the following table, which also contains certain other information relative to the date of introduction of public water supplies into those places so provided, and the rank of each place according to each of the last three decennial censuses. The cities and towns are arranged according to their population in 1910, and all places having water works owned by a private company are designated by an asterisk.

City or Town.	Date of Introduction of Supply.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
Boston,	1848	670,585	-	$1,420,981,033	1	1	1
Worcester,	1845	145,986	-	146,201,068	2	2	2
Fall River,	1874	119,295	-	95,129,690	4	3	3
Lowell,	1872	106,294	-	85,175,700	3	4	4
Cambridge,	1856	104,839	-	114,094,902	5	5	5
New Bedford,	1869	96,652	-	87,503,240	9	8	6
Lynn,	1871	89,336	-	74,081,912	6	6	7
Springfield,	1874	88,926	-	116,218,874	8	9	8
Lawrence,	1875	85,892	-	64,241,036	7	7	9
Somerville,	1867	77,236	-	65,411,419	10	10	10
Holyoke,	1873	57,730	-	50,506,650	11	11	11
Brockton,	1880	56,878	-	43,911,145	15	12	12

City or Town.	Date of Introduction of Supply.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
MALDEN,	1870	44,404	-	$45,004,522	19	16	13
HAVERHILL,	1802	44,115	-	32,577,268	14	13	14
SALEM,	1868	43,697	-	36,023,941	12	14	15
NEWTON,	1876	39,806	-	80,837,081	18	17	16
FITCHBURG,	1872	37,826	-	30,815,118	20	18	17
TAUNTON,	1876	34,259	-	25,326,745	16	19	18
EVERETT,	1867	33,484	-	27,342,393	32	21	19
QUINCY,	1884	32,642	-	30,606,390	23	23	20
CHELSEA,	1867	32,452	-	25,403,942	13	15	21
PITTSFIELD,	1855	32,121	-	24,474,469	22	25	22
WALTHAM,	1873	27,834	-	28,563,213	21	24	23
Brookline,	1875	27,792	-	118,513,924	30	26	24
CHICOPEE,	1845	25,401	-	13,925,483	26	27	25
GLOUCESTER,	1885	24,398	-	23,264,233	17	20	26
MEDFORD,	1870	23,150	-	24,264,078	31	29	27
NORTH ADAMS,	1861	22,019	-	16,546,648	24	22	28
NORTHAMPTON,	1871	19,431	-	15,006,637	25	28	29
BEVERLY,	1868	18,650	-	36,806,035	34	32	30
Revere,	1884	18,219	-	15,660,186	66	46	31
Leominster,	1873	17,580	-	12,836,174	53	37	32
Attleborough,	1873	16,215	-	15,186,731	49	41	33
Westfield,	1874	16,044	-	9,849,516	38	38	34
Peabody,	1799	15,721	-	11,110,151	37	39	35
MELROSE,	1870	15,715	-	17,063,560	45	36	36
Hyde Park,	1885	15,507	-	15,041,961	36	35	37
WOBURN,	1873	15,308	-	11,638,886	29	31	38
NEWBURYPORT,	1881	14,949	-	13,228,615	27	30	39
Gardner,	1882	14,699	-	7,999,254	46	45	40
MARLBOROUGH,	1883	14,579	-	10,898,089	28	34	41
Clinton,	1882	13,075	-	8,841,229	35	33	42
*Milford,	1881	13,055	-	8,830,094	43	40	43
Adams,	1874	13,026	-	7,165,492	41	44	44
Framingham,	1885	12,948	-	12,041,289	40	43	45
Weymouth,	1885	12,895	-	8,323,916	33	42	46
Watertown,	1885	12,875	-	15,479,139	55	48	47
*Southbridge,	1880	12,592	-	6,392,075	48	47	48

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* Works owned by private company.

City or Town.	Date of Introduction of Supply.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
Plymouth,	1855	12,141	-	$11,596,979	52	49	49
Webster,	1881	11,509	-	10,206,433	56	53	50
Methuen,	1875	11,448	-	6,675,090	77	61	51
Wakefield,	1883	11,404	-	9,671,533	57	52	52
Arlington,	1872	11,187	-	12,040,688	67	54	53
Greenfield,	1870	10,427	-	10,483,859	68	57	54
Winthrop,	1884	10,132	-	12,219,155	137	74	55
Amesbury,	1885	9,894	-	6,352,115	39	51	56
Natick,	1874	9,866	-	8,225,368	42	50	57
North Attleborough,	1884	9,562	-	7,004,337	58	63	58
Danvers,	1876	9,407	-	6,528,501	50	55	59
Winchester,	1873	9,309	-	13,826,399	73	64	60
*Dedham,	1881	9,284	-	14,247,994	54	62	61
West Springfield,	1875	9,224	-	7,305,002	71	65	62
*Northbridge,	1889	8,807	-	5,573,724	82	67	63
Ware,	1886	8,774	-	5,281,108	51	56	64
*Palmer,	1886	8,610	-	4,389,877	59	58	65
Athol,	1875	8,536	-	4,795,239	60	66	66
Easthampton,	1870	8,524	-	5,975,370	92	80	67
Middleborough,	1885	8,214	-	5,053,958	65	68	68
Braintree,	1887	8,066	-	6,477,294	75	75	69
Saugus,	1878	8,047	-	5,832,570	109	87	70
Norwood,	1885	8,014	-	14,510,576	107	82	71
Milton,	1885	7,924	-	30,027,548	94	70	72
*Bridgewater,	1888	7,688	-	3,469,277	97	77	73
Marblehead,	1885	7,338	-	8,165,136	47	60	74
Andover,	1890	7,301	-	8,258,227	63	69	75
Whitman,	1883	7,292	-	4,938,660	88	72	76
Stoneham,	1883	7,090	-	5,182,026	62	71	77
Rockland,	1887	6,928	-	4,234,547	69	86	78
Montague,	1887	6,866	-	4,410,049	61	73	79
Hudson,	1884	6,743	-	4,406,495	79	83	80
Spencer,	1883	6,740	-	4,014,410	44	59	81
Concord,	1873	6,421	-	7,810,410	91	79	82
Maynard,	1889	6,390	-	3,884,701	138	133	83
Stoughton,	1886	6,316	-	3,532,469	74	84	84

* Works owned by private company.

City or Town.	Date of Introduction of Supply.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
Swampscott,	1885	6,204	-	$11,274,093	117	101	85
Great Barrington,	1867	5,926	-	6,270,783	81	76	86
Reading,	1891	5,818	-	5,742,532	100	94	87
Ipswich,	1894	5,777	-	5,150,855	89	97	88
*Grafton,	1886	5,705	-	2,954,956	72	95	89
Winchendon,	1896	5,678	-	4,158,306	93	93	90
Blackstone,	-	-	5,648	2,271,572	64	78	91
Franklin,	1884	5,641	-	3,922,637	76	91	92
Belmont,	1887	5,542	-	6,854,544	166	113	93
North Andover,	1898	5,529	-	5,211,428	106	108	94
Abington,	1887	5,455	-	2,991,324	96	103	95
Westborough,	1879	5,446	-	3,363,258	70	85	96
Wellesley,	1884	5,413	-	15,322,124	111	88	97
Orange,	1878	5,282	-	4,085,123	83	81	98
Mansfield,	1888	5,183	-	4,092,054	113	110	99
Easton,	1887	5,139	-	5,988,598	87	96	100
*Fairhaven,	1894	5,122	-	3,509,891	130	121	101
*Amherst,	1880	5,112	-	3,951,140	86	90	102
Needham,	1890	5,026	-	6,143,578	123	109	103
Chelmsford,	1907	5,010	-	4,615,068	139	112	104
*Hingham,	1880	4,965	-	6,930,664	84	89	105
Ludlow,	1873	4,948	-	3,991,012	177	123	106
Lexington,	1884	4,918	-	8,640,266	118	114	107
South Hadley,	1872	4,894	-	3,227,944	95	102	108
Walpole,	1896	4,892	-	4,556,099	144	120	109
Canton,	1889	4,797	-	4,603,931	85	100	110
Monson,	1895	4,758	-	1,962,990	110	128	111
*Millbury	1895	4,740	-	2,451,189	90	104	112
Barnstable,	-	-	4,676	6,221,967	102	106	113
Uxbridge,	1879	4,671	-	3,069,637	114	118	114
Dartmouth,	-	-	4,378	4,249,897	121	117	115
Provincetown,	1893	4,369	-	2,082,066	80	107	116
Randolph,	1888	4,301	-	2,303,882	103	111	117
Dudley,	1910	4,267	-	1,820,724	127	122	118
Rockport,	1895	4,211	-	3,348,450	101	98	119
Warren,	-	-	4,188	2,063,147	78	105	120

* Works owned by private company.

City or Town.	Date of Introduction of Supply.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
*Lee,	1881	4,106	-	$2,192,875	105	119	121
Wareham,	1894[1] 1906[2]	4,102	-	4,997,052	112	126	122
Foxborough,	1891	3,863	-	2,294,432	128	130	123
Templeton,	-	-	3,756	1,752,055	125	125	124
Tewksbury,	-	-	3,750	1,341,886	149	116	125
*Williamstown,	1859	3,708	-	3,580,541	98	92	126
Dalton,	1884	3,568	-	4,610,160	135	136	127
*Hardwick,	1887	3,524	-	2,013,791	129	132	128
*Agawam,	1877	3,501	-	2,011,454	153	149	129
*Medfield,	1889	3,466	-	1,900,642	209	139	130
Dracut,	1900[3] 1906[4]	3,461	-	2,329,492	173	131	131
*East Bridgewater,	1888	3,363	-	2,303,788	131	135	132
*Oxford,	1906	3,361	-	2,072,912	143	145	133
Leicester,	1891	3,237	-	2,596,652	122	127	134
Falmouth,	1899	3,144	-	9,563,560	146	124	135
Sutton,	-	-	3,078	1,307,877	119	129	136
North Brookfield,	1893	3,075	-	1,707,572	104	99	137
*Lenox,	1875	3,060	-	6,335,406	134	138	138
*Nantucket,	1878	2,962	-	3,473,416	116	137	139
*Barre,	1895	2,957	-	1,908,838	156	172	140
Pepperell,	1909	2,953	-	2,316,594	120	115	141
Westport,	-	-	2,928	1,879,255	145	140	142
*Westford,	1908	2,851	-	2,344,168	155	146	143
Holbrook,	1888	2,816	-	1,615,692	150	162	144
Somerset,	-	-	2,798	1,460,754	165	161	145
Ayer,	1887	2,797	-	2,116,075	160	154	146
Billerica,	1898	2,789	-	2,855,846	152	141	147
*Holliston,	1891	2,711	-	1,727,538	142	148	148
†Medway,	-	-	2,696	1,453,664	126	142	149
Manchester,	1892	2,673	-	16,947,227	189	150	150
*Cohasset,	1886	2,585	-	8,425,307	151	143	151
Norton,	-	-	2,544	1,250,499	191	186	152
*Scituate,	1901	2,482	-	4,635,042	154	152	153
Bourne,	-	-	2,474	4,395,415	214	202	154

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* Works owned by private company.

[1] Onset Water Company.

[2] Wareham Fire District.

† Works under construction.

[3] American Woolen Company, Collinsville.

[4] Dracut Water Supply District.

CITY OR TOWN.	Date of Introduction of Supply.	POPULATION IN 1910.		Valuation, 1910.	RANK ACCORDING TO POPULATION.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
Lancaster,	1885	2,464	-	$4,778,268	157	151	155
Hopkinton,	1884	2,452	-	1,616,003	99	147	156
Kingston,	1886	2,445	-	1,834,323	201	177	157
Auburn,	-	-	2,420	1,242,674	207	205	158
Seekonk,	-	-	2,397	1,283,490	224	200	159
Wilbraham,	-	-	2,332	1,215,648	187	209	160
Hanover,	-	-	2,326	1,619,814	167	164	161
Sharon,	1885	2,310	-	2,824,364	203	171	162
Groveland,	-	-	2,253	1,175,229	158	155	163
Dighton,	-	-	2,235	1,143,556	182	190	164
West Bridgewater,	-	-	2,231	1,315,410	178	195	165
Deerfield,	1903	2,209	-	1,885,442	132	175	166
Wayland,	1878	2,206	-	2,542,454	170	159	167
Brookfield,	1889	2,204	-	1,328,678	115	134	168
Merrimac,	1904	2,202	-	1,297,240	140	165	169
*Hopedale,	1881	2,188	-	6,671,281	238	168	170
*Groton,	1897	2,155	-	4,283,327	171	174	171
Douglas,	1910	2,152	-	1,347,893	179	167	172
Holden,	1905	2,147	-	1,791,207	141	153	173
Shirley,	1903	2,139	-	1,164,290	237	199	174
Acton,	-	-	2,136	2,167,930	181	166	175
Williamsburg,	1903	2,132	-	1,030,390	172	179	176
Harwich,	-	-	2,115	1,420,245	136	156	177
Ashburnham,	1870	2,107	-	1,043,470	168	182	178
*Weston,	1896	2,106	-	8,748,609	200	185	179
*Hull,	1882	2,103	-	5,605,743	258	196	180
Upton,	-	-	2,071	1,154,040	183	178	181
Belchertown,	-	-	2,054	939,207	162	160	182
Charlton,	-	-	2,032	1,307,664	185	183	183
Avon,	1890	2,013	-	979,471	218	194	184
Rehoboth,	-	-	2,001	871,950	190	184	185
Hadley,	1905	1,999	-	1,377,976	199	191	186
Hatfield,	1896	1,986	-	1,388,973	232	216	187
Swansea,	-	-	1,978	1,824,445	211	203	188
Georgetown,	-	-	1,958	1,028,318	163	181	189
Sturbridge,	-	-	1,957	1,069,508	169	173	190

* Works owned by private company.

CITY OR TOWN.	Date of Introduction of Supply.	POPULATION IN 1910.		Valuation, 1910.	RANK ACCORDING TO POPULATION.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
Shrewsbury, ...	-	-	1,946	$1,800,536	213	204	191
*Stockbridge, ...	1862	1,933	-	4,502,608	161	169	192
Dennis, ...	-	-	1,919	1,347,057	133	157	193
Wilmington, ...	-	-	1,858	1,465,908	235	208	194
Hanson, ...	-	-	1,854	1,129,912	230	221	195
*Sheffield, ...	1897	1,817	-	1,114,546	175	188	196
Townsend, ...	-	-	1,761	1,332,153	193	189	197
Hamilton, ...	-	-	1,749	4,419,559	264	206	198
Southborough, . . .	-	-	1,745	3,016,516	164	180	199
Rutland, ...	1896	1,743	-	719,110	261	230	200
Wrentham, ...	1908	1,743	-	1,233,618	147	144	201
Colrain, ...	1902	1,741	-	744,031	198	193	202
*Marshfield, ...	1890	1,738	-	2,002,795	196	187	203
Raynham, ...	-	-	1,725	854,541	221	213	204
Northborough, . . .	1882	1,713	-	1,395,575	176	163	205
Bellingham, . . .	-	-	1,696	895,813	222	197	206
Acushnet, ...	-	-	1,692	805,519	249	236	207
Duxbury, ...	-	-	1,688	2,308,400	180	170	208
Sandwich, ...	-	-	1,688	1,057,182	186	223	209
†Ashland, ...	-	-	1,682	1,210,363	148	214	210
Carver, ...	-	-	1,663	1,530,950	257	250	211
Salisbury, ...	-	-	1,658	890,717	225	211	212
*Northfield, ...	1900	1,642	-	1,415,903	184	176	213
Essex, ...	-	-	1,621	1,212,445	195	201	214
Buckland, ...	-	-	1,573	721,143	205	225	215
Chatham, ...	-	-	1,564	1,286,607	174	192	216
East Longmeadow, . .	-	-	1,553	711,908	-	240	217
*Cheshire, ...	1876	1,508	-	830,342	226	237	218
Shelburne, ...	-	-	1,498	1,310,114	206	215	219
Newbury, ...	-	-	1,482	1,308,349	215	207	220
Huntington, . . .	1899	1,473	-	638,778	217	219	221
West Newbury, . . .	-	-	1,473	1,130,571	188	212	222
Freetown, ...	-	-	1,471	986,314	216	227	223
Marion, ...	1908	1,460	-	4,777,715	283	277	224
Sherborn, ...	-	-	1,428	1,552,583	219	218	225
Yarmouth, ...	-	-	1,420	2,410,192	192	198	226

* Works owned by private company. † Works under construction.

City or Town.	Date of Introduction of Supply.	Population in 1910.		Valuation, 1919.	Rank according to Population.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
Norwell,	-	-	1,410	$1,090,735	202	210	227
Millis,	1891	1,399	-	1,107,323	294	254	228
Lunenburg,	-	-	1,393	1,131,246	241	231	229
Plainville,	1909	1,385	-	794,020	-	-	230
Chester,	1893	1,377	-	741,616	228	222	231
Rowley,	-	-	1,368	769,376	231	228	232
Sterling,	-	-	1,359	1,151,538	233	226	233
Westminster,	-	-	1,353	847,667	197	232	234
Pembroke,	-	-	1,336	997,428	223	234	235
West Brookfield,	-	-	1,327	964,995	204	224	236
*West Stockbridge,	1873	1,271	-	446,220	210	242	237
West Boylston,	-	-	1,270	786,860	124	158	238
Westwood,	-	-	1,266	2,741,179	-	249	239
Mattapoisett,	-	-	1,233	1,936,080	240	253	240
Bedford,	1909	1,231	-	1,449,334	244	239	241
Conway,	-	-	1,230	727,818	312	220	242
Littleton,	-	-	1,229	1,115,794	251	241	243
Clarksburg,	-	-	1,207	266,381	278	274	244
Tisbury,	1887	1,196	-	1,602,750	208	245	245
*Edgartown,	1906	1,191	-	1,230,121	239	238	246
Nahant,	1885	1,184	-	8,076,496	279	243	247
Lincoln,	1874	1,175	-	3,520,205	259	247	248
Topsfield,	-	-	1,174	1,429,710	252	259	249
Erving,	1896	1,148	-	1,051,321	263	269	250
Lakeville,	-	-	1,141	720,555	268	270	251
Middleton,	1876	1,129	-	832,913	269	282	252
New Marlborough,	-	-	1,124	719,494	227	233	253
Sudbury,	-	-	1,120	1,303,166	236	244	254
Hinsdale,	1889	1,116	-	596,959	194	217	255
Stow,	-	-	1,115	956,940	274	263	256
Rochester,	-	-	1,090	667,863	255	266	257
*Oak Bluffs,	1890	1,084	-	1,827,603	245	251	258
Longmeadow,	1895	1,084	-	1,502,854	159	285	259
Orleans,	-	-	1,077	688,122	234	248	260
Hubbardston,	-	-	1,073	702,235	220	235	261
North Reading,	-	-	1,059	731,082	281	258	262

* Works owned by private company.

City or Town.	Date of Introduction of Supply.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
*Sunderland,	1883	1,047	–	$506,690	305	294	263
Harvard,	–	–	1,034	1,353,506	243	246	264
Wellfleet,	–	–	1,022	1,238,537	229	265	265
Southwick,	–	–	1,020	694,768	272	256	266
Wenham,	–	–	1,010	2,787,026	276	281	267
Charlemont,	–	–	1,001	528,663	262	252	268
Berkley,	–	–	999	419,691	275	273	269
†Russell,	–	–	965	743,263	280	287	270
Norfolk,	–	–	960	855,701	273	267	271
*Ashfield,	1904	959	–	651,872	250	272	272
Becket,	–	–	959	527,430	267	264	273
Lanesborough,	–	–	947	529,352	253	291	274
*Gill,	1888	942	–	475,157	265	260	275
Lynnfield,	–	–	911	800,196	293	278	276
Berlin,	–	–	904	562,307	277	262	277
Ashby,	–	–	885	773,888	289	279	278
Mendon,	–	–	880	757,307	270	276	279
Enfield,	–	–	874	730,859	266	257	280
Southampton,	–	–	870	501,659	254	261	281
Brimfield,	–	–	866	560,079	242	275	282
Whately,	–	–	846	484,024	295	296	283
Tyngsborough,	–	–	829	593,866	306	292	284
Princeton,	–	–	818	1,300,734	260	268	285
Dover,	–	–	798	5,738,416	300	306	286
Royalston,	–	–	792	646,519	248	271	287
*Granville,	1910	781	–	480,338	246	255	288
Bolton,	–	–	764	500,181	288	295	289
Granby,	–	–	761	517,006	298	298	290
Petersham,	–	–	757	949,548	247	280	291
Bernardston,	–	–	741	476,784	296	288	292
Dana,	–	–	736	403,751	303	289	293
Leverett,	–	–	728	319,792	302	301	294
Boxford,	–	–	718	1,439,079	284	302	295
Blandford,	1909	717	–	543,592	282	283	296
Boylston,	–	–	714	485,022	297	229	297
Truro,	–	–	655	382,488	271	297	298

* Works owned by private company.

† Works under construction.

City or Town.	Date of Introduction of Supply.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
Richmond,	-	-	650	$387,293	291	303	299
Hampden,	-	-	645	377,961	287	290	300
New Salem,	-	-	639	374,674	285	286	301
Cummington,	-	-	637	338,921	292	300	302
Brewster,	-	-	631	671,144	256	284	303
Egremont,	-	-	605	485,464	286	299	304
Burlington,	-	-	591	628,898	307	309	305
Worthington,	-	-	569	355,341	301	304	306
Sandisfield,	-	-	566	341,085	290	305	307
Plympton,	-	-	561	378,223	311	319	308
Oakham,	-	-	552	382,937	299	310	309
Carlisle,	-	-	551	524,114	326	320	310
Halifax,	-	-	550	542,205	316	312	311
Chesterfield,	-	-	536	319,022	309	308	312
Eastham,	-	-	518	450,951	310	315	313
Savoy,	-	-	503	189,621	314	314	314
Wendell,	-	-	502	261,472	321	317	315
Otis,	-	-	494	278,101	312	321	316
Warwick,	-	-	477	437,072	315	307	317
Pelham,	-	-	467	288,902	325	323	318
Hancock,	-	-	465	316,242	320	326	319
New Braintree,	-	-	464	408,637	313	316	320
Rowe,	-	-	456	195,406	317	311	321
Greenwich,	-	-	452	255,252	318	318	322
West Tisbury,	-	-	437	608,682	-	327	323
Phillipston,	-	-	426	290,313	323	329	324
Hawley,	-	-	424	167,218	319	330	325
Westhampton,	-	-	423	246,043	327	322	326
Paxton,	-	-	416	334,528	330	324	327
Dunstable,	-	-	408	383,556	334	331	328
Plainfield,	-	-	406	178,317	332	333	329
Windsor,	-	-	404	279,326	308	313	330
Florida,	-	-	395	192,832	331	334	331
Monterey,	-	-	388	320,602	324	325	332
Tyringham,	-	-	382	268,462	335	335	333
Leyden,	-	-	363	174,327	336	338	334
Middlefield,	-	-	354	188,908	328	332	335

City or Town.	Date of Introduction of Supply.	Population in 1910.		Valuation. 1910.	Rank according to Population.		
		Places with Water Supplies.	Places without Water Supplies.		1890.	1900.	1910.
Heath,	–	–	346	$172,608	322	328	336
Wales,	–	–	345	291,935	304	293	337
Prescott,	–	–	320	187,046	338	337	338
Boxborough,	–	–	317	268,562	340	341	339
Chilmark,	–	–	282	317,406	339	340	340
Goshen,	–	–	279	252,904	344	342	341
Washington,	–	–	277	278,834	333	339	342
Alford,	–	–	275	190,145	343	347	343
Mashpee,	–	–	270	216,282	342	344	344
Shutesbury,	–	–	267	258,947	329	336	345
Monroe,	–	–	246	172,007	345	343	346
Peru,	–	–	237	140,187	341	348	347
Montgomery,	–	–	217	169,074	346	346	348
Tolland,	–	–	180	198,819	337	345	349
Gay Head,	–	–	162	30,864	349	349	350
Gosnold,	–	–	152	581,341	350	351	351
Holland,	–	–	145	98,541	347	350	352
Mount Washington,	–	–	110	92,144	348	352	353
New Ashford,	–	–	92	50,251	351	353	354

CONSUMPTION OF WATER.

Records of the consumption of water are kept in nearly all of the cities and towns where water is pumped, and in several places supplied by gravity Venturi meters are used to measure the quantity supplied.

The following table gives statistics with regard to the consumption of water in the year 1910 in those cities and towns from which records could be obtained. The daily consumption of water per inhabitant has been obtained by dividing the average daily consumption by the total population of the city or town as determined by the census of 1910. The quantity obtained in this manner is somewhat less than the actual consumption per person using the water because there are in all cities and towns a greater or less number of persons who do not use the public supply. This difference is most marked in those towns which contain villages to which the public water supply has not been extended, and in towns where the works have been in operation but a short time and where water has not come into general use. In some towns the population during the summer months is much greater than that shown by the census returns, and in such cases the consumption per inhabitant as given in the table is higher than it would be if allowance were made for the increased population in the summer. With a few exceptions, however, the difference is not great.

Statistics relating to the Consumption of Water in Various Cities and Towns.

CITY OR TOWN.	Population, 1910.	Average Daily Consumption (Gallons), 1910.	Daily Consumption per Inhabitant (Gallons), 1910.	CITY OR TOWN.	Population, 1910.	Average Daily Consumption (Gallons), 1910.	Daily Consumption per Inhabitant (Gallons), 1910.
Metropolitan Water District:[1] —	1,076,930	117,458,000	109	Bridgewater and East Bridgewater.	11,051	245,000	22
Arlington, .	11,187	938,000	84	Brockton, . .	56,878	2,227,000	39
Belmont, .	5,542	330,000	60	Brookline, . .	27,792	2,476,000	89
Boston, . .	670,585	87,347,000	130	Cambridge, . .	104,839	10,458,000	100
Chelsea, . .	32,452	2,835,000	87	Canton, . . .	4,797	293,000	61
Everett, . .	33,484	2,576,000	77	Chelmsford, . .	5,010	53,000	11
Lexington, .	4,918	346,000	70	Clinton, . .	13,075	593,000	45
Malden, . .	44,404	1,874,000	42	Cohasset, . .	2,585	273,000	106
Medford, . .	23,150	1,422,000	61	Concord, . .	6,421	486,000	76
Melrose, . .	15,715	1,006,000	64	Danvers and Middleton.	10,536	940,000	89
Milton, . .	7,924	309,000	39	Dedham, . .	9,284	1,202,000	129
Nahant, . .	1,184	122,000	103	Easton, . . .	5,139	124,000	24
Quincy, . .	32,642	2,892,000	89	Edgartown, . .	1,191	44,000	37
Revere, . .	18,219	1,313,000	72	Fairhaven, . .	5,122	323,000	63
Somerville, .	77,236	6,190,000	80	Fall River, . .	119,295	5,200,000	44
Stoneham, .	7,090	651,000	92	Falmouth, . .	3,144	294,000	93
Swampscott, .	6,204	413,000	67	Foxborough, . .	3,863	193,000	50
Watertown, .	12,875	881,000	68	Framingham, .	12,948	627,000	48
Winthrop, .	10,132	650,000	64	Franklin, . .	5,641	343,000	61
Abington and Rockland.	12,383	561,000	45	Gardner, . .	14,699	641,000	44
Amesbury, . .	9,894	436,000	44	Gloucester, . .	24,398	1,350,000	55
Andover, . .	7,301	627,000	86	Grafton, . .	5,705	100,000	18
Attleborough, .	16,215	881,000	54	Groton, . . .	2,155	87,000	40
Avon, . . .	2,013	73,000	36	Holliston, . .	2,711	49,000	18
Ayer, . . .	2,797	141,000	50	Holyoke, . .	57,730	5,953,000	103
Bedford, . .	1,231	15,000	12	Hyde Park, . .	15,507	1,147,000	74
Beverly, . .	18,650	1,702,000	91	Ipswich, . .	5,777	242,000	42
Billerica, . .	2,789	109,000	39	Lancaster, . .	2,464	100,000	41

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[1] Including Newton and Hyde Park, which are within the district, but supplied from independent works.

Statistics relating to the Consumption of Water in Various Cities and Towns — Concluded.

City or Town.	Population, 1910.	Average Daily Consumption (Gallons), 1910.	Daily Consumption per Inhabitant (Gallons), 1910.	City or Town.	Population, 1910.	Average Daily Consumption (Gallons), 1910.	Daily Consumption per Inhabitant (Gallons), 1910.
Lawrence, . .	85,892	3,879,000	45	Peabody, . .	15,721	2,645,000	168
Lowell, . . .	106,294	5,443,000	51	Plainville, . .	1,385	35,000	25
Lynn and Saugus,	97,383	7,027,000	72	Plymouth, . .	12,141	1,252,000	103
Manchester, . .	2,673	321,000	120	Provincetown, .	4,369	164,000	38
Mansfield, . .	5,183	387,000	75	Randolph and Holbrook.	7,117	528,000	74
Marblehead, . .	7,338	577,000	79	Reading, . .	5,818	206,000	35
Marion, . . .	1,460	60,000	41	Rockport, . .	4,211	304,000	72
Marlborough, .	14,579	541,000	37	Rutland, . .	1,743	101,000	58
Maynard, . .	6,390	228,000	36	Salem, . . .	43,697	3,935,000	90
Merrimac, . .	2,202	82,000	37	Sharon, . . .	2,310	131,000	57
Methuen, . .	11,448	438,000	38	Shirley, . . .	2,139	62,000	29
Middleborough, .	8,214	341,000	42	Stoughton, . .	6,316	220,000	35
Milford and Hopedale.	15,243	773,000	51	Taunton, . .	34,259	2,150,000	63
Millbury, . .	4,740	191,000	40	Wakefield, . .	11,404	694,000	61
Nantucket, . .	2,962	197,000	67	Walpole, . .	4,892	500,000	102
Natick, . . .	9,866	566,000	57	Waltham, . .	27,834	2,443,000	88
Needham, . .	5,026	332,000	66	Wareham, . .	4,102	103,000	25
New Bedford, .	96,652	7,864,000	81	Webster, . .	11,509	439,000	38
Newburyport, .	14,949	1,020,000	68	Wellesley, . .	5,413	331,000	61
Newton, . .	39,806	2,505,000	63	Westford, . .	2,851	59,000	21
North Andover, .	5,529	221,000	40	Weston, . . .	2,106	105,000	50
North Attleborough,	9,562	495,000	52	Whitman, . .	7,292	212,000	29
North Brookfield, .	3,075	202,000	66	Winchendon, . .	5,678	173,000	30
Norwood, . .	8,014	505,000	63	Woburn, . .	15,308	2,134,000	139
Oak Bluffs, . .	1,084	154,000	142	Worcester, . .	145,986	10,805,000	74
Orange, . . .	5,282	137,000	26	Wrentham, . .	1,743	52,000	30

RAINFALL.

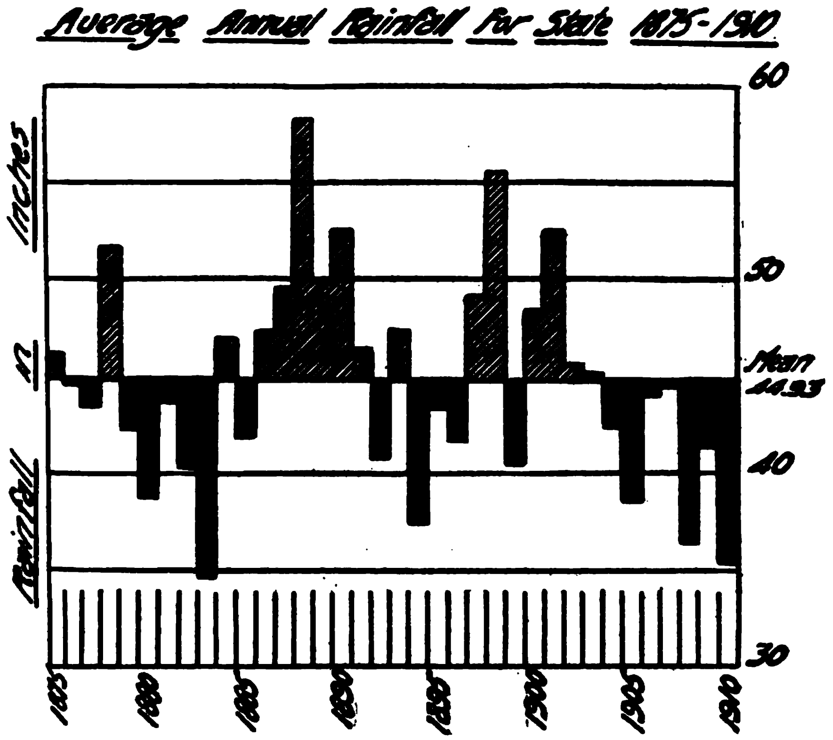
The normal annual rainfall in Massachusetts, as deduced from long-continued observations in various parts of the State, is 44.93 inches. The average rainfall for the year 1910 in these places was 35.63 inches, — an average deficiency of 9.30 inches, the greatest that has occurred in any year since 1883. There was an excess of precipitation in January, February, June and November, but in the remaining eight months of the year there was a deficiency. The greatest excess in any one month occurred in January, when the rainfall was 5.44 inches, or 1.67 inches greater than the normal, and the greatest deficiency occurred in March, when the rainfall was 1.34 inches, or 2.57 inches less than the normal.

The following table gives the normal rainfall in the State for each month as deduced from observations at various places for a long period of years, together with the average rainfall at those places for each month during the year 1910 and the departure from the normal: —

MONTH.	Normal Rainfall (Inches).	Rainfall in 1910 (Inches).	Excess or Deficiency in 1910 (Inches).	MONTH.	Normal Rainfall (Inches).	Rainfall in 1910 (Inches).	Excess or Deficiency in 1910 (Inches).
January, . .	3.77	5.44	+1.67	August, . .	4.24	2.90	−1.34
February, .	3.64	4.63	+0.99	September, .	3.52	2.49	−1.03
March, . .	3.91	1.34	−2.57	October, . .	3.85	1.33	−2.52
April, . .	3.59	2.74	−0.85	November, .	3.92	4.16	+0.24
May, . .	3.74	2.26	−1.48	December, .	3.65	2.15	−1.50
June, . .	3.33	4.15	+0.82	Totals, .	44.93	35.63	−9.30
July, . .	3.77	2.04	−1.73				

Taking the State as a whole there has been a deficiency of rainfall in every year beginning with 1904, and the accumulated deficiency at the end of the year 1910 was 30.50 inches, or an average annual deficiency of 4.36 inches. This deficiency was not distributed equally throughout the period, however, being only 0.15 of an inch in 1907 and 0.84 of an inch in 1906. The deficiency in 1904 and 1909 was 2.46 and 3.37 inches, respectively. About 78 per cent. of the total deficiency in this period occurred in the years 1905, 1908 and 1910, when the deficiency was, respectively, 6.17, 8.21 and 9.30 inches, the latter alone being almost one-third of the total deficiency for the entire period. The unusual dryness of the year 1910, and also of the year 1908, is very noticeable in the diagram on page 223, showing the average annual rainfall througout the State for each year since 1875.

The effect of a year of such low rainfall as that of 1910, following six other years in which the rainfall was less than the normal, was to produce a drought which caused a heavy draft upon the ponds and reservoirs used as sources of water supply and reduce them to lower levels than ever before. In several places the regular sources of supply were exhausted, or reduced to such low levels that it was necessary to supplement the supply with water taken from the nearest available stream or reservoir, the waters of some of which were found to be of inferior or suspicious quality. In other places the introduction of a supplementary supply was only avoided by the adoption and rigid enforcement of certain restrictions upon the use of water from the public works.



FLOW OF STREAMS.

Sudbury River.

The average flow of the Sudbury River during the year 1910 was 570,000 gallons per day per square mile, or 56 per cent. of the normal flow for the past thirty-six years. In that period the only year in which the average flow has been less was 1883, when the flow was 533,000 gallons per day per square mile, or 52 per cent. of the normal flow. In 1910 the flow during the month of June was normal; in the months of January and February it was in excess of the normal; but in the remaining nine months of the year it was less than the normal, the greatest deficiency occurring in the months of March, April, May, November and December. During the months of July, August and October the flow was less than the evaporation from the water surfaces of the reservoirs, so that the flow is represented by a minus quantity. The average flow for the driest six months, July to December, inclusive, was 29,000 gallons per day per square mile, or 7 per cent. of the normal flow and 72 per cent. of the minimum flow ever before recorded for a similar period during the past thirty-six years.

In order to show the relation between the flow of the Sudbury River during each month of the year 1910 and the normal flow of that stream as deduced from observations during thirty-six years, from 1875 to 1910, inclusive, the following table has been prepared. The area of the watershed of the Sudbury River above the point of measurement is 75.2 square miles.

Table showing the Average Monthly Flow of the Sudbury River for the Year 1910, in Cubic Feet per Second per Square Mile of Drainage Area, and in Million Gallons per Day per Square Mile of Drainage Area; also, Departure from the Normal Flow.

MONTH.	NORMAL FLOW.		ACTUAL FLOW IN 1910.		EXCESS OR DEFICIENCY	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.900	1.228	2.305	1.490	+0.405	+0.262
February,	2.729	1.764	2.861	1.849	+0.132	+0.085
March,	4.388	2.836	3.023	1.954	—1.365	—0.882
April,	3.102	2.005	1.031	0.667	—2.071	—1.338
May,	1.668	1.078	0.429	0.277	—1.239	—0.801
June,	0.797	0.515	0.799	0.516	+0.002	+0.001
July,	0.264	0.171	—0.158	—0.102	—0.422	—0.273
August,	0.382	0.247	—0.113	—0.073	—0.495	—0.320
September,	0.388	0.251	0.008	0.005	—0.380	—0.246
October,	0.702	0.454	—0.078	—0.051	—0.780	—0.505
November,	1.253	0.810	0.273	0.176	—0.980	—0.634
December,	1.576	1.019	0.342	0.221	—1.234	—0.798
Average for whole year,	1.589	1.027	0.881	0.570	—0.708	—0.457

In the annual report of the State Board of Health for the year 1908 (pages 234 to 239) and for the year 1909 (page 267) tables were presented giving the record of rainfall upon the Sudbury River watershed, and the yield expressed in inches in depth upon the watershed (inches of rainfall collected), for thirty-five years, from 1875 to 1909, inclusive. The corresponding record for the year 1910, together with an average for the whole period of thirty-six years, is given in the following table: —

Rainfall, in Inches, received and collected on the Sudbury River Watershed.

MONTH.	FOR THE YEAR 1910.			MEAN FOR THIRTY-SIX YEARS, 1875-1910.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	5.39	2.657	49.2	4.17	2.190	52.5
February,	5.06	2.979	58.9	4.24	2.865	67.5
March,	0.85	3.486	408.7	4.39	5.059	115.2
April,	2.75	1.151	41.9	3.51	3.461	98.5
May,	1.29	0.495	38.4	3.34	1.923	57.6
June,	4.68	0.891	19.0	3.15	0.889	28.2
July,	2.03	—0.182	—9.0	3.56	0.304	8.5
August,	2.62	—0.130	—5.0	3.85	0.441	11.5
September,	2.49	0.008	0.3	3.52	0.433	12.3
October,	1.86	—0.091	—4.9	3.93	0.809	20.6
November,	4.13	0.304	7.4	3.84	1.398	36.5
December,	2.49	0.395	15.8	3.81	1.817	47.7
Year,	35.64	11.963	33.6	45.31	21.589	47.6

The following table gives a record of the yield of the Sudbury River watershed for each of the past thirty-six years, the flow being expressed in gallons per day per square mile of watershed in order to render the table more convenient for use in estimating the probable yield of watersheds used as sources of water supply: —

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile.[1]

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.
January,	103,000	643,000	658,000	1,810,000	700,000	1,121,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000
March,	1,604,000	4,435,000	4,813,000	3,507,000	2,330,000	1,374,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,168,000
May,	1,188,000	1,139,000	1,391,000	1,394,000	1,114,000	514,000
June,	870,000	222,000	597,000	506,000	413,000	176,000
July,	321,000	183,000	202,000	128,000	158,000	177,000
August,	396,000	405,000	121,000	475,000	395,000	119,000
September,	207,000	184,000	60,000	160,000	141,000	80,000
October,	646,000	234,000	632,000	516,000	71,000	101,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000
December,	548,000	454,000	1,289,000	3,177,000	462,000	175,000
Average for whole year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000
Average for driest six months,	574,000	384,000	502,000	532,000	230,000	143,000

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[1] The area of the Sudbury River watershed used in making up these records included water surfaces amounting to about 2 per cent. of the whole area, from 1875 to 1878 inclusive, subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1879, to 3.5 per cent. in 1885, to 4 per cent. in 1894 and to 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Continued.

MONTH.	1881.	1882.	1883.	1884.	1885.	1886.
January,	415,000	1,241,000	335,000	995,000	1,235,000	1,461,000
February,	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000	4,800,000
March,	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000
April,	1,546,000	867,000	1,350,000	2,853,000	1,815,000	1,947,000
May,	965,000	1,292,000	938,000	1,030,000	1,336,000	720,000
June,	1,338,000	529,000	300,000	417,000	426,000	203,000
July,	276,000	86,000	115,000	224,000	62,000	115,000
August,	148,000	55,000	78,000	257,000	240,000	94,000
September,	197,000	306,000	91,000	44,000	121,000	118,000
October,	186,000	299,000	186,000	83,000	336,000	146,000
November,	395,000	210,000	205,000	175,000	1,178,000	673,000
December,	775,000	314,000	193,000	925,000	1,174,000	1,020,000
Average for whole year,	979,000	862,000	533,000	1,129,000	901,000	1,087,000
Average for driest six months,	330,000	211,000	145,000	200,000	391,000	223,000

MONTH.	1887.	1888.	1889.	1890.	1891.	1892.
January,	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000
February,	2,829,000	1,951,000	1,195,000	1,529,000	3,486,000	943,000
March,	2,868,000	3,237,000	1,339,000	3,643,000	4,453,000	1,955,000
April,	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000
May,	1,009,000	1,632,000	880,000	1,366,000	582,000	1,259,000
June,	414,000	422,000	653,000	568,000	414,000	428,000
July,	114,000	117,000	633,000	108,000	149,000	214,000
August,	214,000	380,000	1,432,000	132,000	163,000	280,000
September,	111,000	1,155,000	824,000	458,000	203,000	229,000
October,	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000
November,	368,000	2,758,000	1,941,000	1,215,000	305,000	697,000
December,	643,000	3,043,000	2,241,000	997,000	544,000	485,000
Average for whole year,	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000
Average for driest six months,	234,000	953,000	944,000	747,000	239,000	327,000

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Continued.

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.
January,	433,000	693,000	1,034,000	1,084,000	845,000	1,638,000
February,	1,542,000	991,000	541,000	2,676,000	1,067,000	3,022,000
March,	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000	2,604,000
April,	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000	1,829,000
May,	2,883,000	840,000	636,000	360,000	915,000	1,246,000
June,	440,000	419,000	174,000	399,000	962,000	530,000
July,	158,000	161,000	231,000	95,000	658,000	231,000
August,	181,000	209,000	229,000	57,000	591,000	1,107,000
September,	108,000	150,000	89,000	388,000	182,000	369,000
October,	221,000	374,000	1,379,000	592,000	94,000	1,160,000
November,	319,000	836,000	2,777,000	659,000	909,000	1,986,000
December,	797,000	716,000	1,782,000	657,000	1,584,000	1,799,000
Average for whole year,	1,037,000	770,000	1,152,000	1,019,000	991,000	1,450,000
Average for driest six months,	237,000	356,000	460,000	314,000	564,000	777,000

MONTH.	1899.	1900.	1901.	1902.	1903.	1904.
January,	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000
February,	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000
March,	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000
April,	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000
May,	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000
June,	66,000	316,000	753,000	303,000	1,987,000	419,000
July,	19,000	—18,000	306,000	66,000	445,000	62,000
August,	—35,000	—34,000	424,000	135,000	307,000	170,000
September,	94,000	65,000	305,000	178,000	130,000	397,000
October,	115,000	186,000	412,000	506,000	492,000	191,000
November,	304,000	663,000	474,000	444,000	363,000	289,000
December,	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000
Average for whole year,	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000
Average for driest six months,	93,000	194,000	445,000	271,000	388,000	228,000

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Concluded.

MONTH.	1905.	1906.	1907.	1908.	1909.	1910.	Mean for 36 Years, 1875–1910.
January,	1,410,000	1,128,000	1,351,000	1,925,000	392,000	1,490,000	1,228,000
February,	330,000	1,041,000	624,000	1,536,000	2,286,000	1,849,000	1,764,000
March,	2,497,000	2,409,000	1,658,000	2,257,000	1,734,000	1,954,000	2,836,000
April,	1,643,000	1,949,000	1,607,000	1,117,000	1,721,000	667,000	2,005,000
May,	297,000	1,059,000	888,000	1,046,000	1,004,000	277,000	1,078,000
June,	467,000	707,000	761,000	194,000	239,000	516,000	515,000
July,	177,000	398,000	9,000	—14,000	—121,000	—102,000	171,000
August,	114,000	180,000	—104,000	102,000	—45,000	—73,000	247,000
September,	1,246,000	19,000	541,000	—82,000	149,000	5,000	251,000
October,	158,000	301,000	741,000	47,000	—51,000	—51,000	454,000
November,	279,000	483,000	1,998,000	71,000	82,000	176,000	810,000
December,	887,000	659,000	2,032,000	136,000	263,000	221,000	1,019,000
Average for whole year,	795,000	860,000	1,010,000	694,000	625,000	570,000	1,027,000
Average for driest six months,	403,000	341,000	471,000	44,000	40,000	29,000	406,000

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, due to unavoidable inaccuracies in the measurement of the quantity of water received from the Wachusett Reservoir.

Nashua River.

The average flow of the South Branch of the Nashua River above Clinton during the year 1910 was 828,000 gallons per day per square mile, or 73 per cent. of the normal flow, making the year the driest since the record was begun in 1897. The flow during the months of January and February was in excess of the normal, but in the remaining ten months of the year it was less than the normal. The greatest excess occurred in January, and the greatest deficiency in April and December. The average flow for the driest six months, July to December, inclusive, was 201,000 gallons per day per square mile, or 35 per cent. of the normal flow, and 84 per cent. of the minimum flow, ever before recorded for a similar period during the past fourteen years.

In order to show the relation between the flow of the Nashua River during each month of the year 1910 and the normal flow of that stream, as deduced from observations during fourteen years, from 1897 to 1910, inclusive, the following table has been prepared. The area of the watershed of the Nashua River above the point of measurement was 119 square miles from 1897 to 1907, inclusive, and 118.19 square miles in 1908, 1909 and 1910.

Table showing the Average Monthly Flow of the South Branch of the Nashua River for the Year 1910, in Cubic Feet per Second per Square Mile of Drainage Area, and in Million Gallons per Day per Square Mile of Drainage Area; also, Departure from the Normal Flow.

MONTH.	NORMAL FLOW.		ACTUAL FLOW IN 1910.		EXCESS OR DEFICIENCY.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.923	1.243	2.857	1.846	+0.934	+0.603
February,	2.302	1.487	2.854	1.845	+0.552	+0.358
March,	4.311	2.786	4.084	2.639	—0.227	—0.147
April,	3.412	2.205	1.600	1.034	—1.812	—1.171
May,	1.857	1.200	0.941	0.608	—0.916	—0.592
June,	1.303	0.842	1.274	0.824	—0.029	—0.018
July,	0.683	0.441	0.096	0.062	—0.587	—0.379
August,	0.676	0.437	0.288	0.186	—0.388	—0.251
September,	0.621	0.401	0.224	0.145	—0.397	—0.256
October,	0.830	0.536	0.106	0.068	—0.724	—0.468
November,	1.267	0.819	0.548	0.354	—0.719	—0.465
December,	1.971	1.273	0.605	0.391	—1.366	—0.882
Average for whole year,	1.760	1.137	1.281	0.828	—0.479	—0.309

In the annual report of the State Board of Health for the year 1908 (pages 243–245) and for the year 1909 (page 271) tables were presented giving the record of rainfall upon the Nashua River watershed and the yield expressed in inches in depth on the watershed (inches of rainfall collected) for thirteen years from 1897 to 1909, inclusive. The corresponding record for the year 1910, together with the average for the whole period of fourteen years, is given in the following table: —

Rainfall, in Inches, received and collected on the Nashua River Watershed.

MONTH.	FOR THE YEAR 1910.			MEAN FOR FOURTEEN YEARS, 1897-1910.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	5.86	3.293	56.2	3.80	2.217	58.3
February,	5.24	2.972	56.7	4.00	2.409	60.2
March,	1.09	4.708	432.7	4.25	4.970	117.0
April,	3.01	1.785	59.2	3.98	3.806	95.7
May,	2.13	1.085	51.0	3.43	2.141	62.3
June,	4.36	1.422	32.6	4.16	1.454	35.0
July,	1.52	0.110	7.2	4.22	0.787	18.7
August,	3.87	0.332	8.6	4.23	0.779	18.4
September,	2.86	0.250	8 7	3.93	0.693	17.6
October,	1.40	0.122	8.7	3.34	0.957	28.7
November,	4.17	0.612	14 6	3.40	1.413	41.6
December,	2.34	0.697	29.8	4.34	2.271	52.3
Year,	37.85	17.388	45.9	47.08	23.897	50.8

The following table gives a record of the yield of the Nashua River watershed for each of the past fourteen years, the flow being expressed in gallons per day per square mile of watershed: —

Yield of the Nashua River Watershed in Gallons per Day per Square Mile.[1]

MONTH.	1897.	1898.	1899.	1900.	1901.
January,	796,000	1,563,000	2,092,000	796,000	519,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000
June,	1,181,000	828,000	561,000	578,000	985,000
July,	1,442,000	333,000	354,000	217,000	477,000
August,	896,000	1,325,000	236,000	197,000	512,000
September,	380,000	676,000	250,000	127,000	320,000
October,	243,000	1,509,000	245,000	282,000	647,000
November,	1,283,000	2,170,000	430,000	875,000	517,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000
Average for whole year,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000
Average for driest six months,	886,000	1,013,000	312,000	377,000	576,000

MONTH.	1902.	1903.	1904.	1905.	1906.
January,	1,676,000	1,265,000	659,000	1,266,000	1,132,000
February,	1,401,000	2,133,000	927,000	452,000	1,027,000
March,	3,992,000	3,423,000	3,008,000	3,004,000	1,860,000
April,	2,159,000	2,238,000	2,984,000	1,617,000	2,109,000
May,	1,031,000	569,000	1,498,000	445,000	1,533,000
June,	410,000	2,131,000	762,000	542,000	1,184,000
July,	292,000	624,000	497,000	365,000	728,000
August,	297,000	474,000	355,000	321,000	591,000
September,	241,000	375,000	494,000	1,228,000	277,000
October,	950,000	689,000	347,000	367,000	530,000
November,	635,000	634,000	343,000	442,000	749,000
December,	1,848,000	954,000	440,000	1,018,000	794,000
Average for whole year,	1,248,000	1,285,000	1,025,000	926,000	1,043,000
Average for driest six months,	471,000	626,000	413,000	541,000	613,000

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[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent. in 1904, to 4.1 per cent. in 1905, to 5.1 per cent. in 1906, to 6 per cent. in 1907, and to 7 per cent. in 1908, 1909, and 1910.

Yield of the Nashua River Watershed in Gallons per Day per Square Mile — Concluded.

MONTH.	1907.	1908.	1909.	1910.	Mean for 14 Years, 1897-1910.
January,	1,458,000	1,738,000	592,000	1,846,000	1,243,000
February,	692,000	1,736,000	2,556,000	1,845,000	1,487,000
March,	1,697,000	2,192,000	2,129,000	2,639,000	2,786,000
April,	1,436,000	1,269,000	2,422,000	1,034,000	2,205,000
May,	965,000	1,415,000	1,212,000	608,000	1,200,000
June,	773,000	403,000	632,000	824,000	842,000
July,	335,000	220,000	233,000	62,000	441,000
August,	87,000	443,000	193,000	186,000	437,000
September,	810,000	88,000	208,000	145,000	401,000
October,	1,382,000	158,000	90,000	68,000	536,000
November,	2,540,000	125,000	363,000	354,000	819,000
December,	1,961,000	387,000	537,000	391,000	1,273,000
Average for whole year,	1,180,000	847,000	918,000	828,000	1,137,000
Average for driest six months,	725,000	238,000	271,000	201,000	578,000

Merrimack River.

The flow of the Merrimack River has been measured for many years at Lawrence, above which place the river has a watershed area of 4,664 square miles, which includes at the present time about 118 square miles on the South Branch of the Nashua River, 75 square miles on the Sudbury River and 19 square miles tributary to Lake Cochituate, or a combined area of 212 square miles from which water is drawn for the supply of the Metropolitan Water District. The flow as measured at Lawrence includes the water wasted from these three watersheds, which, in the wet months of the year, is very considerable, but which becomes very small in the dry months. Records of the quantity of water wasted have been kept by the Boston Water Board and by the Metropolitan Water Board, and these quantities have been deducted from the flow as measured at Lawrence. The area of the three watersheds has also been deducted from the watershed area at Lawrence, so that the net area was 4,570 square miles up to March 1, 1898, at which time the Nashua River was diverted, 4,451 square miles from March 1, 1898, to Jan. 1, 1908, and 4,452 square miles in 1908, 1909 and 1910.

The average flow of the Merrimack River during the year 1910 was about 68 per cent. of the normal flow for the past twenty-three years for which records are available. In 1910 the flow was in excess of the normal in the month of March, but less than the normal in the remaining eleven months of the year. The greatest deficiency in any month occurred in April.

In order to show the relation between the flow of this stream during each month of the year 1910 and the normal flow as deduced from observations during twenty-three years from 1888 to 1910, inclusive, the following table has been prepared: —

Table showing the Average Monthly Flow of the Merrimack River for the Year 1910 in Cubic Feet per Second per Square Mile of Drainage Area; also, the Departure from the Normal.

MONTH.	Normal Flow. — Cubic Feet per Second per Square Mile.	Actual Flow in 1910. — Cubic Feet per Second per Square Mile.	Excess or Deficiency. — Cubic Feet per Second per Square Mile.
January,	1.487	1.043	—0.444
February,	1.463	0.973	—0.490
March,	3.075	3.611	+0.536
April,	3.796	2.445	—1.351
May,	2.351	1.509	—0.842
June,	1.316	1.077	—0.239
July,	0.739	0.398	—0.341
August,	0.665	0.458	—0.207
September,	0.722	0.397	—0.325
October,	0.974	0.300	—0.674
November,	1.258	0.457	—0.801
December,	1.368	0.335	—1.033
Average for the whole year,	1.601	1.084	—0.517

Sudbury, Nashua and Merrimack Rivers.

The following table shows the weekly fluctuation during 1910 in the flow of the three streams just described, — namely, the Sudbury River at Framingham, the South Branch of the Nashua River above Clinton and the Merrimack River at Lawrence. The flow of these streams, particularly that of the Sudbury and of the South Branch of the Nashua River, serves to indicate the flow of other streams in eastern Massachusetts. The area of the Sudbury River watershed is 75.2 square miles and of the South Branch of the Nashua River 118.19 square miles. The net watershed area of the Merrimack River is 4,452 square miles.

Table showing the Average Weekly Flow of the Sudbury, South Branch of the Nashua and Merrimack Rivers for the Year 1910 in Cubic Feet per Second per Square Mile of Drainage Area.

WEEK ENDING SUNDAY.	FLOW IN CUBIC FEET PER SECOND PER SQUARE MILE.			WEEK ENDING SUNDAY.	FLOW IN CUBIC FEET PER SECOND PER SQUARE MILE.		
	Sudbury River.	South Branch Nashua River.	Merrimack River.		Sudbury River.	South Branch Nashua River.	Merrimack River.
Jan. 2, . .	0.047	0.492	0.390	July 3, . .	0.006	0.278	0.604
9, . .	1.349	1.882	0.360	10, . .	—0.141	0.003	0.425
16, . .	0.951	1.417	0.461	17, . .	0.124	0.033	0.454
23, . .	4.219	5.500	1.060	24, . .	—0.346	—0.005	0.353
30, . .	3.408	3.322	2.462	31, . .	—0.076	0.272	0.363
Feb. 6, . .	1.897	1.553	1.122	Aug. 7, . .	0.044	0.191	0.534
13, . .	1.736	1.393	0.827	14, . .	—0.111	0.785	0.462
20, . .	1.693	1.851	0.805	21, . .	—0.043	0.288	0.459
27, . .	3.478	3.678	1.121	28, . .	—0.154	0.032	0.436
Mar. 6, . .	8.942	10.542	4.726	Sept. 4, . .	—0.077	0.367	0.286
13, . .	3.437	4.682	3.934	11, . .	0.179	0.337	0.447
20, . .	1.221	2.486	2.460	18, . .	—0.112	—0.005	0.417
27, . .	1.535	2.644	2.963	25, . .	—0.115	0.119	0.366
Apr. 3, . .	1.042	1.666	3.697	Oct. 2, . .	—0:066	0.099	0.361
10, . .	0.734	1.103	2.677	9, . .	—0.198	0.193	0.333
17, . .	0.573	0.989	1.421	16, . .	—0.143	0.024	0.325
24, . .	1.349	1.797	2.055	23, . .	0.095	0.126	0.297
May 1, . .	1.694	2.534	3.164	30, . .	—0.013	0.135	0.280
8, . .	0.578	1.149	2.260	Nov. 6, . .	0.662	0.982	0.361
15, . .	0.458	0.950	1.470	13, . .	0.167	0.494	0.653
22, . .	0.359	0.870	1.166	20, . .	—0.121	0.172	0.460
29, . .	0.073	0.735	1.111	27, . .	0.106	0.257	0.331
June 5, . .	0.113	0.957	0.989	Dec. 4, . .	0.383	0.596	0.412
12, . .	1.711	2.162	1.106	11, . .	—0.145	0.178	0.349
19, . .	1.395	1.918	1.414	18, . .	0.005	0.190	0.252
26, . .	0.304	0.539	0.970	25, . .	1.037	0.912	0.261
				Jan. 1, 1911, .	0.619	1.513	0.430

LAWRENCE EXPERIMENT STATION REPORT

FOR 1910.

EXPERIMENTS UPON THE PURIFICATION OF SEWAGE AND WATER AT THE LAWRENCE EXPERIMENT STATION.[1]

By H. W. CLARK and STEPHEN DEM. GAGE.

The following report summarizes the results of the studies upon the purification of sewage and water during the year ending Nov. 30, 1910.

During the year thirty-eight filters have been in operation in investigations upon the purification of domestic sewage, seventeen upon the treatment of manufactural wastes and eleven upon the purification of water. The sand filters to which sewage has been applied for twenty-three years, and the trickling and contact filters operated for eleven and nine years, respectively, have been continued. The prolonged operation of these various filters continues to yield valuable information concerning many problems relating to sewage purification and to the methods of operation necessary to maintain sewage filters in good working condition. Particular attention has been paid to methods of preliminary clarification of sewage designed to prevent the clogging of various types of filters, and thus to increase the length of life of such filters and their capacity to purify sewage. The disposal of sludge, which is one of the most serious problems in the purification of sewage on a large scale, has received attention, as in past years. Studies of tanks for the concentration of sludge, and of certain filters constructed of horizontal layers of slate, installed in 1909 and first operated at Lawrence in 1901, have been continued. The purification of waste liquors from scouring and washing wool, also the purification of wastes from a yeast factory and from a rubber mill, have been investigated during the year. Studies of great interest have been begun to show the effect of carbonaceous matter of different kinds and in varying amounts upon the purification of different varieties of sewage, for carbonaceous matter forms by far the larger part of the organic matter in most sewages, especially in industrial sewage, and its decomposition and disposal cause some of the chief difficulties met with in sewage purification. The effect under some conditions of carbonaceous bodies of certain kinds is exceedingly inimical to the occurrence of nitrification in filters.

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[1] The work has been carried on under the general supervision of Hiram F. Mills, A.M., C.E., member of the State Board of Health, with Mr. H. W. Clark, chemist to the Board, in direct charge. Mr. Stephen DeM. Gage, biologist, and Mr. George O. Adams, chemist, are the principal assistants at the station. A full account of the work done at the Lawrence Experiment Station during the years 1888 and 1889 was contained in a special report of the State Board of Health upon the purification of sewage and water (1890). A similar account for the years 1890 and 1891 is contained in the twenty-third annual report of the Board for 1891. Since 1891 the results have been published yearly in the annual reports; a review of all work at Lawrence upon sewage purification was published in the annual report of the Board for 1908, and the report for 1909 contained a review of the work on factory wastes.

The water purification studies have included the operation of slow sand and mechanical filters. The studies upon disinfection in connection with filtration, reported last year, have been continued. Furthermore, investigations have been begun upon the preliminary clarification by upward filtration through coarse material, and upon intermittent filtration by a sand filter upon which water is sprinkled in the same way that sewage is applied to a trickling filter.

Recently, serious complaint has been made that waters which have been subjected to certain purification processes are rendered more corrosive in their action upon various kinds of pipes, hot-water tanks, boiler tubes and other metallic surfaces with which they have come in contact. This problem has been under investigation during the past year at the experiment station to determine to what extent such corrosive action *is* affected by different water-purification processes, and, if possible, to devise remedies.

In connection with the enforcement of recent legislation regulating the amount of humidity and the quality of water which may be used in artificial humidifiers, an investigation of the air in the textile mills has been started to determine to what extent the bacterial content of the air is influenced by the use of humidifiers, or by the quality of water used in such humidifiers, and also to determine the reliability as measures of moisture of various forms of hygrometers.

In addition, a considerable portion of the investigation ordered by the last Legislature, of the pollution of the Merrimack River by trades wastes, has devolved upon the experiment station staff. Inspections as to the amount of the fouling of the shores and boats, the relative proportions of fouling due to domestic sewage and to mill wastes, and studies upon the character and composition of the various wastes and of the deposits upon the shores and boats moored in the river, have been made.

ANALYSIS OF SEWAGE.

The sewage used at the station is pumped through a 2½-inch pipe about 4,400 feet long. The following tables present the results of the usual analyses of the various representative samples of sewage collected during the year. "Lawrence Street sewage" is the average of samples collected weekly from the sewer from which the sewage is pumped; "regular sewage" is the average of samples collected at the experiment station on at least four days each week; "sewage applied to Filters Nos.

1, 6 and 9A" is the average of daily samples of the sewage applied to each of these filters, and is representative also of sewage applied to the other intermittent filters situated out of doors; "Andover regular sewage" is the average of weekly samples of the town sewage before it enters the settling tank at the Andover filtration area; and "fresh sewage" is an average of a representative sample of all the sewage from the toilet room at the station during one day in each week.

Lawrence Street Sewage.

[Parts per 100,000.]

Temperature (Degrees F.).	Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Albuminoid.								
	Free.	Total.	In Solution.	Total.	In Solution.		Nitrates.	Nitrites.		
63	2.08	0.76	0.47	2.52	1.73	12.10	.07	.0062	8.82	1,507,300

Regular Sewage.

55	3.77	0.65	0.33	1.27	0.61	13.00	-	-	4.90	2,095,600

Sewage applied to Filters Nos. 1, 6 and 9A.

-	3.53	0.54	-	0.97	-	11.40	-	-	4.11	-

Andover Regular Sewage.

-	3.42	0.98	0.57	2.01	1.00	9.59	-	-	6.55	3,476,100

Fresh Sewage.

59	3.02	1.47	0.88	8.94	7.14	9.09	-	-	7.22	3,158,200

Solids in Regular Sewage.

[Parts per 100,000.]

1910.	Unfiltered.			Filtered.			In Suspension.		
	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
Average, . .	66.5	28.3	38.2	51.3	16.6	34.7	15.2	11.7	3.5

Solids in Fresh Sewage.

Average, . .	70.6	43.3	27.3	57.1	31.1	26.0	13.5	12.2	1.3

PRELIMINARY TREATMENTS FOR CLARIFICATION OF SEWAGE.

Studies upon the clarification of sewage before filtration have been continued during 1910. The large settling tank, installed in 1906 for the clarification of the sewage applied to trickling and contact filters at the station, has been continued in operation. This is a cylindrical tank with a sloping bottom, near which the sewage enters and then rises slowly to an outlet near the top, the period of sedimentation being about two hours and the maximum velocity of the rising sewage being about one inch per minute. The accumulated sludge has been removed from this tank each week. During the year the average removal of matters in suspension by this tank has been about 53 per cent. as shown by albuminoid ammonia determinations, and about 71 per cent. as shown by determinations of total and organic solids. The total removal of organic matter has been 34 per cent. as shown respectively by the total albuminoid ammonia and by the oxygen consumed determinations, and about 29 per cent. as shown by total organic solids.

In 1899 experiments were begun at the station upon the treatment of the sludge from a settling tank by biological action in a separate tank, and the results obtained with this tank and the reasons for such treatment were discussed in the report for 1899, and also in subsequent reports. The Imhoff tank developed in Germany and the Travis tank developed in England during recent years are based upon the same principles, and are elaborations and improvements upon this early Lawrence tank.

A tank of this construction was installed at the station in 1909 for the clarification of the absolutely fresh sewage from the toilet room at the experiment station. It is a cylindrical tank with a conical bottom sloping at an angle of 60°, inside of which is a tank of similar design. The inner tank, or settling basin, is provided with a baffle plate, and has a large outlet through which the deposited solid matters pass into the outer or digestion chamber, where they are allowed to accumulate and decompose. The outlet of the settling tank is trapped in such a manner that the gases and other products of decomposition from the digestion chamber cannot pass back into the settling tank, and the sewage is thus kept relatively fresh. The capacity of the outer tank is equivalent to about twenty-four hours' flow of sewage from the toilet room, and that of the inner tank to about five hours' flow. During the year there were removed by this tank about 53 per cent. of the suspended matters in the sewage as shown by albuminoid ammonia determinations, and 42 per cent. as shown by determinations of total solids. About 33 per cent. of the total organic matter in the sewage was removed during its passage through the tank as shown by albuminoid ammonia determinations, 22 per cent. as shown by oxygen consumed determinations and about 38 per cent. as shown by determinations of total organic solids.

At the end of the year 1909, after five months' operation, an amount of sludge had accumulated that was equivalent to about 25 cubic feet per million gallons of sewage treated, and amounting to about 2.3 per cent. of the capacity of the tank. On Dec. 31, 1910, after about eighteen months' operation, sludge equivalent to about 200 cubic feet per million gallons of sewage treated, amounting to about 70 per cent. of the capacity of the tank, was contained within the digestion chamber, and during the year sludge equivalent to about 114 cubic feet per million gallons treated was removed from the tank, to prevent it from backing up into the settling chamber. The sludge as drawn from the bottom of the tank was of a thick, gruel-like consistency, with an extremely offensive odor. The odor was not that of hydrogen sulphide, nor that of ordinary sludge from settling and septic tanks, but distinct and penetrating, and was probably due to organic decomposition products, such as indole, skatole, etc. More or less odor has been noticeable about this tank at all times. The sludge drawn from the bottom of the tank was of such a nature that it retained its integrity for some days, and the solids and water did not separate on standing, as is usual with sludges from other sources. Analyses of this sludge showed it to contain 87.2 per cent. of water, 11.5 per cent. of organic matter and 1.3 per cent. of mineral matter. As regards destruction of sludge, the tank was a failure. While some fermentation occurred within the tank, as was evident by the evolution of gas and the presence of a crust of floating matter at the top of the digestion chamber, the sum of the total solids contained within the tank at the end of the year, and of the solids in the sludge withdrawn from time to time, approximates very closely the total amount of suspended matters removed from the sewage in its passage through the settling chamber. It must be borne in mind, however, that the sewage entering this tank is absolutely fresh, and that there has been no opportunity for disintegration of the solids before they arrived at the tank, as would have been the case had ordinary sewage been used, and also that the proportion of urine in this sewage is abnormally large as compared with the amount of fecal matters.

The work of the settling tank, which is a part of the sewage-disposal system of the town of Andover, has also been noted, as in previous years. This tank has a capacity of about 13,500 gallons, and the average time required for the sewage to pass through it is approximately two hours. The average removal of suspended matters by this tank during the period from April to November, 1910, inclusive, was about 49 per cent., as shown by albuminoid ammonia determinations. About 66 per cent. and 54 per cent. of the total organic matters were removed, as shown by albuminoid ammonia and oxygen consumed determinations, respectively.

Strainer E, containing 12 inches in depth of buckwheat coal, was put into operation in 1901, and has been operated at a rate of 800,000 gallons per acre daily throughout 1910. Sixty-six per cent. of suspended matter was removed, as shown by albuminoid ammonia determinations; and the total removal of organic matter was about 39 per cent., as shown by albuminoid ammonia and oxygen consumed determinations. The work of this strainer is remarkable and in some respects unexplainable. Year after year it removes large percentages of suspended matter from the sewage, and by some biological process not fully understood appears to destroy this matter with great rapidity. During the entire nine and one-half years which this strainer has been receiving sewage at rates of from 800,000 to 1,500,000 gallons per acre daily, averaging 1,000,000 gallons per acre daily, sludge has been removed from the surface only twice, and the filtering material has been raked or otherwise disturbed only four times. The two scrapings were made during the first year of operation. Of the four other disturbances of material, three were necessitated by the collapse of the tank, requiring the transfer of the material to a new tank. From Sept. 23, 1905, when the material was last transferred, to Jan. 28, 1910, when the strainer was raked to a depth of 3 inches, or during a period of four and one-third years, no treatment of the surface or removal of sludge was required.

In addition to these methods of preliminary treatment of sewage, studies have been made with tanks constructed of layers of slate and operated on the contact principle. The results of the operation of these tanks will be found on pages 249 to 253, inclusive.

Analyses of the sewage before and after clarification by the different methods are shown in the following tables: —

Regular Sewage.

[Parts per 100,000.]

Temperature (Degrees F.).	AMMONIA.			KJELDAHL NITROGEN.		Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	ALBUMINOID.						
		Total.	In Solution.	Total.	In Solution.			
55	3.77	0.65	0.33	1.27	0.61	13.00	4.90	2,095,600

Settled Sewage.

[Parts per 100,000.]

Temperature (Degrees F.).	Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.						
		Total.	In Solution.	Total.	In Solution.			
64	3.54	0.43	0.28	0.82	0.51	12.41	3.21	1,386,300

Effluent from Strainer E.

-	2.48	0.40	0.29	0.75	0.57	12.54	3.01	874,200

Andover Regular Sewage.

-	3.42	0.98	0.57	2.01	1.00	9.59	6.55	3,476,100

Andover Settled Sewage.

-	2.83	0.50	0.36	0.95	0.68	9.89	2.99	1,461,800

Fresh Sewage (entering Imhoff Tank).

59	3.02	1.47	0.88	8.94	7.14	9.09	7.22	3,158,200

Effluent from Imhoff Tank.

-	9.17	0.98	0.70	1.83	1.29	8.19	5.65	1,730,000

Solids in Settled Sewage.

[Parts per 100,000.]

1910.	Unfiltered.			Filtered.			In Suspension.		
	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
Average, . .	53.9	20.0	33.9	49.5	16.7	32.8	4.4	3.3	1.1

Solids in Effluent from Imhoff Tank.

Average, . .	54.5	26.6	27.9	46.7	20.1	26.6	7.8	6.5	1.3

SAND FILTERS, $\frac{1}{200}$ OF AN ACRE IN AREA, NOS. 1, 2, 4, 5C, 6, 9A AND 10.

At the end of 1910, Filters Nos. 1, 2, 4 and 6 had been operated for nearly twenty-three years, and Filters Nos. 9A and 10 for about twenty and sixteen years, respectively. Since 1893, a period of seventeen years, these filters have been operated without removal of sand from their surface. During 1910 all of these filters produced effluents of a satisfactory quality and none of them showed any appreciable increase of clogging due to stored organic matter. The actual volume of sewage applied to each filter from the beginning of operation to Dec. 1, 1910, is as follows: —

	Gallons.
Filter No. 1,	2,395,532
Filter No. 2,	1,299,156
Filter No. 4,	809,176
Filter No. 5C,	409,750
Filter No. 6,	1,931,004
Filter No. 9A,	1,900,819
Filter No. 10,	668,085

There has been of late years considerable discussion in regard to the permanence of intermittent sand filters by those who believe that such filters are simply "retention beds" for a large part of the organic matter applied to them. There is no doubt, as has been shown in previous reports of the station, that such filters may become clogged by overwork; that is, by the application of a greater volume of sewage than can be cared for. In the review of the Lawrence work given in the report for 1908 many tables were given to show the relative amounts of applied organic matter of different kinds that were oxidized, stored or unaccounted for on account of escape into the air in gaseous forms. In the discussion it was brought out clearly that while the purifying work of a filter was measured largely by analyses of the different combinations of nitrogen in the sewage applied and in the effluent, still the nitrogenous organic matter formed but a small part of the organic matter in sewage, and hence its change in the filter formed but a small part of the work of the filter, this being especially true of sand filters or other filters of fine material. With trickling filters of material too coarse to act as a strainer, a speedy oxidation of the nitrogenous organic matter is the main requirement. This is not true of sand filters in which carbonaceous matters in large amounts are retained. Sand Filter No. 1 has received during its twenty-three years' operation, to Dec. 1, 1910, 2,395,532 gallons of sewage. This sewage has contained about 30 pounds of organic matter in every 12,000 gallons, or a total weight of about 6,000 pounds of organic matter applied to this small filter, and of this, about 3,400 pounds have been organic matter in suspension. Of this total organic matter, Filter No. 1 has retained and stored only 3.5 per cent. of the applied nitrogen and about 13 per cent. of the total organic matter. In other words, the filter has successfully cared for, without retention, 96.5 per cent. of the applied nitrogen and 87 per cent. of the total applied organic matter. Relatively speaking, a very minute portion of this organic matter has appeared unoxidized in the filter effluent. These statements are true of the other sand filters, in operation now for many years. Analyses of the sand at various depths in Filters Nos. 1, 6 and 9A, in July, 1910, showed that the amount of stored nitrogen was not increasing.

Filter No. 1.

Filter No. 1, constructed of 60 inches in depth of sand of an effective size of 0.48 millimeter, is 1/200 of an acre in area, and was first put into operation on Jan. 10, 1888. Regular station sewage has been applied to this filter six days a week at a rate of 50,000 gallons per acre daily throughout the year. During the winter the surface of the filter was trenched, and from December 13 to March 7 the trenches were covered with boards. On March 26 the trenches were dug over to a depth of 6 inches, and the surface of the filter was leveled and dug over to a depth of 10 inches. On July 15 the surface was dug over to a depth of from 8 to 10 inches, and on November 22 the surface was dug over to a depth of 3 inches and the filter was trenched for the winter, as in previous years. The filter was rested from July 10 to 19, inclusive. The portion of the surface to which sewage was applied was raked to a depth of 1 inch eight times during the period when the trenches were covered with boards, and once each week during the remainder of the year.

Filter No. 2.

Filter No. 2, constructed of 60 inches in depth of fine sand of an effective size of 0.08 millimeter, is 1/200 of an acre in area, and was first put into operation on Dec. 19, 1887. The surface of the filter is arranged with circular trenches 1 foot wide and 2 feet deep, of medium sand of an effective size of 0.19 millimeter, the surface of the sand being below the surface of the remainder of the filter. Regular station sewage was applied to these trenches at a rate of 40,000 gallons per acre daily throughout the year. From December 13 to March 7, inclusive, the trenches were covered with boards. The sand in the trenches was dug over to a depth of from 6 to 10 inches on March 26, July 16 and November 22. The surface of the sand in the trenches was raked six times during the portion of the year when covered with boards, and once a week during the remainder of the year. The filter was rested from July 10 to 19, inclusive.

Filter No. 4.

Filter No. 4, constructed of 60 inches in depth of fine river silt of an effective size of 0.04 millimeter, is 1/200 of an acre in area, and was first put into operation on Dec. 19, 1887. The surface of the filter is arranged with circular trenches about 14 inches wide and 12 inches deep, of coarse sand of an effective size of 0.48 millimeter, the surface of the sand being below that of the remainder of the filter. Regular station sewage was applied to this filter three days a week at an average rate of 40,000 gallons per acre daily. The trenches were covered with boards from December 13 to March 7, inclusive. The sand in the trenches was dug over to a depth varying from 6 to 10 inches on March 26, July 16 and November 22. During the period when covered with boards, the surface of the sand in the trenches was raked to a depth of 1 inch six times, and during the remainder of the year it was so raked once each week. The filter was rested from July 10 to 19, inclusive, and was not operated, owing to high water, from March 2 to 7, inclusive.

Filter No. 5C.

Filter No. 5C, constructed of 60 inches in depth of sand of an effective size of 0.22 millimeter, is 1/200 of an acre in area, and was first put into operation on July 20, 1905. Regular station sewage was applied at a rate of 50,000 gallons per acre daily throughout the year. During the winter the surface of the filter was trenched, and from December 13 to March 7 the trenches were covered with boards. On March 26 the trenches were dug over to a depth of 6 inches, and the surface was leveled and dug over to a depth of 10 inches. On July 15 the surface was dug over to a depth of from 8 to 10 inches, and on November 22 the surface was dug over to a depth of 3 inches and the filter was trenched for the winter, as in previous years. During the period when covered with boards the surface of the sand in the trenches was raked six times, and during the remainder of the year the surface of the trenches, or the whole surface of the filter when it was level, was raked once each week. The filter was rested from July 10 to 19, inclusive, and was out of service from March 2 to 6, inclusive, owing to high water.

Filter No. 6.

Filter No. 6, constructed of 44 inches in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter, is 1/200 of an acre in area, and was first put into operation on Jan. 12, 1888. The filter has been operated with regular station sewage, at a rate of 50,000 gallons per acre daily throughout the year. During the winter the surface of the filter was trenched, and from December 13 to March 7 the trenches were covered with boards. On March 26 the trenches were dug over to a depth of 6 inches, and the surface of the filter was leveled and dug over to a depth of 10 inches. On July 15 the surface was dug over to a depth of from 8 to 10 inches, and on November 22 the surface was dug over to a depth of 3 inches and the filter was trenched for the winter, as in previous years. During the time when the trenches were covered with boards the sand in the trenches was raked to a depth of 1 inch six times, and during the remainder of the year the entire surface of the filter was raked 1 inch deep each week. The filter was rested from July 10 to 19, inclusive, and was out of service, owing to high water, from March 2 to 6 and from March 8 to 9, inclusive.

Filter No. 9A.

Filter No. 9A, constructed of 60 inches in depth of sand of an effective size of 0.17 millimeter, is $1/200$ of an acre in area, and was first put into operation on Nov. 18, 1890. Regular station sewage was applied at a rate of 50,000 gallons per acre daily six days a week throughout the year. The surface of the filter was trenched during the winter, and from December 13 to March 7 the trenches were covered with boards. On March 26 the trenches were dug over to a depth of 6 inches and the surface of the filter was leveled and dug over to a depth of 10 inches. On July 15 the surface was dug over to a depth of from 8 to 10 inches, and on November 22 the surface was dug over to a depth of 3 inches and the filter was trenched for the winter. During the period when the trenches were covered with boards the surface was raked six times, and during the remainder of the year the whole surface of the filter was raked to a depth of 1 inch each week. The filter was rested from July 11 to 19, and was out of service from March 2 to 6, inclusive, and March 8 and 9, owing to high water.

Filter No. 10.

Filter No. 10, $1/200$ of an acre in area, is constructed of 60 inches in depth of mixed fine and coarse sand of an effective size of 0.35 millimeter, and was first put into operation on July 18, 1894. No underdrains are beneath the sand except directly around the outlet pipe. A partition extending 3 feet below the surface separates the quarter of the surface which is farthest from the underdrains from the remainder of the surface, and to this quarter the sewage is applied. For a number of years the portion of surface which does not receive sewage has been covered with a compact layer of loam 8 inches in depth, which practically prevented the entrance of air from that portion of the surface. On June 3, a portion of this covering was removed, and the sand in a strip 2 feet wide extending across the filter was exposed, thus permitting the free entrance of air to this portion of the filter. Regular station sewage was applied to this filter six days each week at a rate equivalent to 30,000 gallons per acre daily for the whole area, or 120,000 gallons per acre daily for the portion of the surface flooded. Unlike the other large filters situated out of doors, the surface of this filter was neither trenched nor covered with boards during the winter. The portion of the surface to which sewage was applied was dug over to a depth of from 8 to 10 inches on July 15 and November 22. From December 1 to March 31 the surface was raked to a depth of 1 inch ten times, and during the remainder of the year it was raked once each week. The filter was rested from April 20 to June 2 and from July 11 to 19, inclusive, and was out of service on account of high water from March 2 to 6 and March 8 to 9, inclusive. During the winter, ice was removed from the surface six times, the total amount removed amounting to about 1¾ inches. Snow was removed from the surface twelve times, the total amount removed being about 76 inches.

Effluent from Filter No. 1.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature (Deg. F.).		Length of Time Sewage remained on Surface (Minutes).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Bacteria per Cubic Centimeter.
	Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
47,900	60	54	12	0.4	.31	.6157	.0616	10.30	3.60	.0010	.60	6,200

Effluent from Filter No. 2.

38,200	60	53	26	0.0	.16	.1505	.0239	10.17	3.02	.0030	.35	975

Effluent from Filter No. 4.

18,700	60	52	9	0.0	.10	.0691	.0168	10.14	3.36	.0018	.24	195

Effluent from Filter No. 5C.

46,800	60	54	18	0.4	.27	.3749	.0482	9.91	3.37	.0005	.50	5,600

Effluent from Filter No. 6.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		Length of Time Sewage remained on Surface (Minutes).	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS		Oxygen consumed.	Bacteria per Cubic Centimeter.
	Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
46,500	60	55	28	0.1	.21	.3761	.0403	10.61	3.43	.0024	.43	2,160

Effluent from Filter No. 9A.

47,000	59	55	35	0.2	.29	.3606	.0457	10.20	2.81	.0001	.51	1,290

Effluent from Filter No. 10.

28,500	59	55	28	0.3	.31	.3675	.0558	8.90	1.83	.0008	.52	2,565

Average Solids in Effluents from Filters Nos. 1 and 2.

Effluent from Filter No. 1.

[Parts per 100,000.]

DATE.	UNFILTERED.		
	Total.	Loss on Ignition.	Fixed.
December, 1909–November, 1910, . . .	54.2	17.5	36.7

Effluent from Filter No. 2.

December, 1909–November, 1910, . . .	46.8	13.3	33.5

CONTACT FILTRATION.

Filters Nos. 175, 376 and 377.

Studies upon purification by contact filtration have been continued, and three contact filters were operated for this purpose during 1910. One, Filter No. 175, is constructed of coke, and has been in operation about ten years; the other two, Nos. 376 and 377, are constructed of horizontal layers of slate, and have been in operation for about one and one-half years to study the deposition and destruction of sludge by this method. Such filters were first operated at the station in 1901, and they have been exploited abroad during recent years.

Filter No. 175, $\frac{1}{20000}$ of an acre in area and 5 feet in depth, was first put into operation on June 3, 1901, and is constructed of pieces of coke of such size that all will pass through a sieve having a 1-inch mesh, 75 per cent. through a $\frac{1}{2}$-inch mesh and practically none through a sieve with a $\frac{1}{4}$-inch mesh. This filter has always received strained sewage, is filled once daily with one application of sewage, allowed to stand full two hours before draining, and rested every sixth week. Its average rate of operation during 1910 was about 359,000 gallons per acre daily. On Dec. 1, 1909, 52 per cent. of the original open space of this filter was occupied by deposited matters. Until the end of May the open space of the filter remained fairly constant, but during July and August the amount of deposited matters increased until about 63 per cent. of the voids in the material were filled. During the latter portion of the year the filter gradually relieved itself of this clogging material, and the open space at the end of the year was only slightly less than at the beginning of the year.

Filters Nos. 376 and 377, put into operation on July 9, 1909, are constructed of layers of roofing slate placed horizontally, the layers of slate being separated from one another by small concrete blocks three-fourths of an inch thick. Filter No. 376 has a superficial area of about $\frac{1}{4200}$ of an acre, and contains 27 layers of slate, the exposed surface available for the deposition of sludge being about 314 square inches for each gallon of sewage contained within the filter. Filter No. 377 has a superficial area of about $\frac{1}{6500}$ of an acre, and contains 8 layers of slate, the area available for the deposition of sludge amounting to about 187 square inches per gallon of sewage. Both filters are so arranged that the layers of slate can be cleaned by flushing. Filter No. 376 has received regular station sewage and Filter No. 377 the fresh supernatant sewage from the Imhoff tank, both filters being operated as contact filters and filled in one dose applied daily. Until June 1, 1910, the sewage was allowed to remain within the filter for two hours, but after that date the contact period was reduced to one hour. Both filters have been operated six days a week without systematic resting.

The average removal of suspended matters by Filter No. 376 during the year was about 41 per cent. as shown by determinations of albuminoid ammonia in suspension, and about 39 per cent. as shown by determinations of total solids in suspension. The total removal of organic matters was about 22 per cent. as shown by albuminoid ammonia determinations, and 25 per cent. as shown by determinations of oxygen consumed and total organic solids. The average removal of suspended matters by Filter No. 377 was about 11 per cent. as shown by determinations of albuminoid ammonia in suspension, and about 53 per cent. as shown by determinations of total solids in suspension. The total removal of organic matters during the year by this filter was 11 per cent. as shown by the albuminoid ammonia determinations, 7 per cent. as shown by the determinations of oxygen consumed and 16 per cent. as shown by determinations of total organic solids. In comparing the removal of suspended matters by these two filters, it should be borne in mind that a considerable proportion of the suspended matters had been removed from the sewage before it was applied to Filter No. 377, while none of the suspended matters had been removed from the regular sewage applied to Filter No. 376.

On March 19 sludge equivalent to about 1 per cent. of the capacity of the filter was removed from Filter No. 376. At the end of the year about 10 per cent. of the capacity of each filter was occupied by accumulated sludge. Up to the end of April there was a gradual increase in the amount of sludge held in Filter No. 376. During the summer, however, a considerable amount of this sludge was eliminated, and much of the lost open space was recovered.

Further than the removal of suspended matters, the amount of actual purification accomplished by these two filters has been very small, and nitrification has been feeble. The average amount of nitrates in the effluent from Filter No. 376 during the year was only .09 part per 100,000, and in the effluent from Filter No. 377 only .27 part. Judging from the results during the year, and from the experience obtained with similar filters operated in 1901 and 1902, filters or tanks of this type cannot be expected to accomplish more than a preliminary clarification of sewage, and for this reason they should perhaps be classed and compared in efficiency with other clarification treatments. It will be noted that slate Filter No. 376 was far less successful in removing suspended matters than either the coal strainer or the settling tank operated with the same sewage. The value of the slate-filled tanks for the digestion of sludge, and for giving it such a composition and consistency that it may readily be disposed of, cannot be stated from the results at present available.

The average analyses of the sewage applied to and of the effluents from Filters Nos. 175, 376 and 377 follow: —

Average Analyses of Sewage applied to and of Effluents from Contact Filters Nos. 175, 376 and 377.

Effluent from Strainer E applied to Filter No. 175.

[Parts per 100,000.]

Quantity applied. Gallons per Acre Daily.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as		Oxygen consumed.	Bacteria per Cubic Centimeter.
	Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.			Nitrates.	Nitrites.		
-	-	-	2.4800	.4000	.2900	.7500	12.54	-	-	3.01	874,200
Effluent from Filter No. 175.											
358,900	4.3	.87	0.6775	.2303	.1665	.4330	12.52	1.78	.0124	1.61	553,300
Sewage applied to Filter No. 376.											
-	-	-	4.5800	.7900	.4200	1.51	13.56	-	-	4.93	-
Effluent from Filter No. 376.											
575,000	6.3	.93	4.1177	.6202	.4005	1.1395	13.12	0.09	.0048	3.67	1,105,600
Sewage applied to Filter No. 377.											
-	-	-	9.1700	.9800	.7000	1.8300	8.19	-	-	5.65	1,730,000
Effluent from Filter No. 377.											
221,000	7.0	-	7.0010	.8725	.6238	1.5975	8.23	0.27	.0250	5.26	2,123,500

Average Solids.

Effluent from Filter No. 175.

[Parts per 100,000.]

Unfiltered.			Filtered.			In Suspension.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
54.1	15.9	38.2	49.4	12.3	37.1	4.7	3.6	1.1
Sewage applied to Filter No. 376.								
68.5	28.7	39.8	49.2	13.4	35.8	19.3	15.3	4.0

Average Solids — Concluded.

Effluent from Filter No. 376.

[Parts per 100,000.]

Unfiltered.			Filtered.			In Suspension.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
58.7	21.5	37.2	47.0	12.2	34.8	11.7	9.3	2.4
Sewage applied to Filter No. 377.								
54.5	26.6	27.9	46.7	20.1	26.6	7.8	6.5	1.3
Effluent from Filter No. 377.								
51.5	22.3	29.2	47.8	20.1	27.7	3.7	2.2	1.5

OPERATION OF TRICKLING FILTERS.

Filters Nos. 135, 136, 222, 248, 360, 361, 362, 391 and 392.

During 1910, ten trickling filters have been operated, eight at the experiment station and two at the Andover filtration area. Of the eight filters at the station, six were constructed of broken stone, one of clinker and one of metallurgical coke. Two of the broken stone filters, Nos. 135 and 136, have been in operation for over eleven years. With three filters, Nos. 360, 361 and 362, the effect of different size and character of material, of different depths of filtering material, and of uniform and uneven distribution of the sewage upon the surface have been studied comparatively. With two filters, a direct comparison has been made of the relative ease of purification of settled sewage at Lawrence and Andover. Filter No. 363 has been used in studies of the refiltration of trickling filter effluents, and will be found described in a subsequent portion of this report. All of these filters, except Filter No. 222, have had the sewage applied to them by means of automatic tipping basins discharging into perforated pans, as described in previous reports. Filter No. 222, which is of the same size as the large sand filters at the station, is located at Andover, and has had sewage applied to it by means of a large mechanical distributor of the Fiddian type.

Filters Nos. 135 and 136, $\frac{1}{20000}$ of an acre in area, are constructed of 10 feet in depth of broken stone, all of which will pass through a screen with a 1-inch mesh, 40 per cent. through a screen with a $\frac{1}{2}$-inch mesh and 4 per cent. through a screen with a $\frac{1}{4}$-inch mesh. These filters were first put into operation in November, 1899. Settled sewage has been applied to each throughout the year at a rate of approximately 2,000,000 gallons per acre daily, the filters being operated seven days a week, and receiving one hour's rest night and morning. Operated in this manner, the filters have continued to yield well-nitrified effluents at all times, and no trouble from clogging has been experienced.

Filter No. 248, $\frac{1}{20000}$ of an acre in area and constructed of 8 feet in depth of material of the same grade as that in Filters Nos. 135 and 136, was first put into operation on May 16, 1904. Settled sewage has been applied to this filter six days each week throughout the year at a rate of 2,000,000 gallons per acre daily. Nitrification has been active within the filter, and the effluent of the filter has been nonputrescible.

Filter No. 222, $\frac{1}{200}$ of an acre in area, is located at Andover, and was first put into operation in July, 1903. In April, 1906, the filter was rebuilt, and at present consists of 6 inches of cobble stones above Akron pipe underdrains, overlaid with 7 feet of broken stone all of which will pass through a screen with a 1½-inch mesh and none of which will pass through a screen with a ¾-inch mesh. Andover settled sewage was applied to this filter seven days each week from April 1 to the end of the year at a rate of 1,500,000 gallons per acre daily, by means of a self-propelled traveling distributor of the Fiddian type. A description of this distributor was given on pages 293 and 294 of the report for 1909.

As noted in that report, the effect of more uniform distribution of the sewage upon the surface of this filter resulted in an increase in nitrification and an improvement in the quality of the effluent over that of previous years. The improved nitrification has been even more marked during the past year.

A comparison of the uniformity of distribution and of the quality of the effluent from this filter when operated with the two different types of distributors may be of interest. As the revolving distributor could not be operated during the winter months, only the summer months, June to October, inclusive, may be used in such a comparison. During these months the amount of nitrates in the effluent from the filter averaged 0.01 in 1907 and 0.57 in 1908. During these two years sewage was applied by the dashplate distributor, about 24 per cent. of the surface receiving little or no sewage, about 23 per cent. of the surface receiving sewage at rates of between 500,000 and 1,000,000 gallons per acre daily, about 17 per cent. of the surface receiving sewage at rates of from 1,000,000 to 2,000,000 gallons per acre daily, about 20 per cent. of the surface receiving sewage at rates of from 2,000,000 to 4,000,000 gallons per acre daily, the remaining 16 per cent. of the surface receiving sewage at rates of from 4,000,000 to 7,500,000 gallons per acre daily.

The rotary distributor was installed in April, 1909, and distribution measurements showed that about half the surface received sewage at approximately the intended rate, that is, between 1,000,000 and 2,000,000 gallons per acre daily, while about one-fourth of the surface received less than 1,000,000 gallons per acre daily, and the remaining fourth of the surface received sewage at a greater rate than 2,000,000 gallons per acre daily. The highest rate on any portion of the surface with this type of distributor, however, was only 3,250,000 gallons per acre daily, or about half of the maximum rate at which sewage had been applied by the dashplate system. Immediately following the installation of the rotary distributor, nitrification increased, the average nitrates in the effluent during the following six weeks being 0.69 part, a result higher than had ever been obtained with this filter previously. The nitrates in the effluent from the filter averaged 1.09 parts per 100,000 during the summer of 1909, and 1.69 parts during the same period of 1910. This improvement in purification during the past two years can be attributed only to the improvement in the uniformity of distribution of the sewage. The filter has been operated at approximately the same rate during the periods quoted in all four years, and, with the exception of a slight increase in strength, the character of the applied sewage has remained unchanged.

Filters Nos. 360, 361 and 362. — These square filters, each $\frac{1}{10000}$ of an acre in area and containing 8 feet 9 inches in depth of material held in place by open cob-work sides, were started Nov. 14, 1908. Filters Nos. 360 and 361 were constructed of pieces of broken stone having a mean diameter between 1 and 2 inches, and Filter No. 362 was filled with pieces of hard clinker having a mean diameter of from 4 to 6 inches. All of these filters had underdrain channels open at each end in order that any sediment might be readily flushed out. Small half-round drains were placed in the material in Filter No. 361 at different levels, from which samples were collected regularly to show the amount of purification of the sewage after it had passed through 2, 4, 6 and 8 feet of filter material, respectively. Settled sewage was applied to each of these filters at a rate of about 1,500,000 gallons per acre daily until October 31. On November 1 Filters Nos. 361 and 362 were discontinued, and the rate of Filter No. 360 was increased to 2,000,000 gallons per acre daily. In the present discussion only the period from Dec. 1, 1909, to Oct. 30, 1910, will be considered. The distribution of sewage upon Filters Nos. 361 and 362 has been practically uniform over the whole surface, while the distribution upon the surface of Filter No. 360 has been so arranged that although the net rate upon the entire area was the same as that on Filters Nos. 361 and 362, the sewage was applied at a gradually increasing rate from one side of the filter surface to the other, as is the case with portions of the surface of trickling filters, which are equipped with distributors of the nozzle or dashplate types. The underdrain system of this filter is divided into three distinct collecting areas of equal size, and the whole filter may thus be considered to be composed of three separate filters united in one container, these being designated as Nos. 360A, 360B and 360C. Frequent measurements have been made of the rate at which sewage is applied to each of these sections, and separate samples of the effluent have been regularly collected from each underdrain system. The operation of these three filters during the past two years furnishes a number of interesting comparisons.

During both years the amounts of free and albuminoid ammonia were less in the effluent from the filter of large pieces of clinker than in the effluent from that constructed of a smaller grade of broken stone. Nitrification was slightly more active within the clinker filter during the first year, but the reverse was the case during the second year, and the average nitrates during the two years were practically identical.

Samples from the different depths in Filter No. 360 illustrate the continual increase in purification of the sewage as it passes through a trickling filter, and emphasize the desirability of deep filters. The average amount of free ammonia during the two years decreased from 3.75 parts per 100,000 in the settled sewage to 2.70 parts after passing through the first 2 feet of material, to 2.39 after passing 4 feet, to 2.08 after passing 6 feet and to 1.93 after passing the entire filter, a progressive reduction of 28, 37, 45 and 49 per cent., respectively. Nitrification also increased, almost in proportion to the depth of filter through which the sewage had passed. The average amount of nitrates in the effluent during the two years was 0.38 part after passing 2 feet of material, 0.80 part after passing 4 feet of material, 1.14 parts after passing 6 feet and 1.25 parts after passing the entire filter.

The effect of uniform and unequal distribution is not so well shown as was hoped when Filters Nos. 360 and 361 were planned. The average effluents from both filters were satisfactorily purified and were much the same in quality. If anything, the effluent from Filter No. 361, upon which the sewage was uniformly distributed, was slightly inferior to that from Filter No. 360, having an unequal distribution of sewage. From this it should not be assumed, however, that uniform distribution of sewage upon filters of this type is unnecessary, as the effect of unequal distribution was evidently overbalanced by other factors. The difference between the highest and lowest rates upon different portions of Filter No. 360 is much less than the differences in rates upon adjacent portions of trickling filters, to which sewage is applied by means of fixed distributing nozzles. Furthermore, the highest rate at which sewage was applied to any portion of Filter No. 360 averaged only about 2,000,000 gallons per acre daily, at which rate satisfactory purification has been obtained at times with other trickling filters at the station. With a larger filter and improved differential distribution and collection systems, the effect of unequal distribution would undoubtedly be much more strongly marked. The results illustrate to a certain degree, however, how the effluent from a filter may be a mixture of effluents from different portions of that filter in very different stages of purification. For example, the average effluent from the entire filter containing about 1.54 parts nitrates per 100,000 was a mixture of 52 per cent. of the effluent from Section A, containing 1.14 parts nitrates; 32 per cent. of the effluent from Section B, containing 1.89 parts nitrates, and 16 per cent. of the effluent from Section C, containing 2.12 parts nitrates.

Filters Nos. 391 and 392 were put into operation on April 29, 1910, to study comparatively the purification by trickling filters of the settled sewage obtained at the experiment station and at the Andover filtration area. These filters were 1/80000 of an acre in area, and were constructed of 8 feet in depth of pieces of broken stone between ½-inch and 1½ inches in diameter. Filter No. 391 was located at the experiment station and Filter No. 392 at Andover. Each of these filters was operated at a rate of 1,000,000 gallons per acre daily until the end of October. Nitrification was somewhat slower in starting in the filter receiving the Andover settled sewage, but during the months of August, September and October, when nitrification was active in both filters, the nitrates in the effluent from the filter located at Andover averaged over 3 parts per 100,000, or about twice as great as in the effluent from the filter receiving the Lawrence settled sewage. These results apparently contradict the statements made in previous reports that poor purification of Andover settled sewage by trickling filters was in part attributable to the character of the sewage, and confirm the statements made elsewhere in this report that the purification of this sewage in a satisfactory manner by properly constructed trickling filters is largely a question of rates and of uniform distribution of the sewage over the surface of such filters.

The average analyses of the effluents from these various trickling filters are shown in the following tables: —

Average Analyses.

Effluent from Filter No. 135 (10 Feet Deep).

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	APPEARANCE.		AMMONIA.			Kjeldahl Nitrogen.	Chlorine.	NITROGEN AS		Oxygen consumed.	Bacteria per Cubic Centimeter.
				ALBUMINOID.							
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.		
1,922,000	2.3	.63	0.5711	.2549	.1573	.4463	12.08	2.68	.0051	1.98	22,300

Effluent from Filter No. 136 (10 Feet Deep).

1,882,400	2.8	.68	1.0381	.2509	.1736	.4438	12.09	1.82	.0054	1.98	70,800

Average Solids in Effluent from Filter No. 136.

UNFILTERED.			FILTERED.			IN SUSPENSION.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
52.3	17.4	34.9	49.0	15.1	33.9	3.3	2.3	1.0

Average Analyses.

Effluent from Filter No. 248 (8 Feet Deep).

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	APPEARANCE.		AMMONIA.			Kjeldahl Nitrogen.	Chlorine.	NITROGEN AS		Oxygen consumed.	Bacteria per Cubic Centimeter.
				ALBUMINOID.							
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.		
1,935,800	3.4	.70	1.3746	.5468	.2397	.9456	12.58	2.06	.0071	3.12	287,800

Effluent from Filter No. 222.

-	-	.63	1.7531	.3617	.1851	.6371	10.50	1.25	.0462	2.00	256,000

Effluent from Filter No. 360 (Section A).

1,988,000	4.0	.76	1.7798	.3809	.2247	.6016	12.45	1.14	.0216	2.37	199,400

Average Analyses — Concluded.

Effluent from Filter No. 360 (Section B).

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	APPEARANCE.		AMMONIA.			Kjeldahl Nitrogen.	Chlorine.	NITROGEN AS		Oxygen consumed.	Bacteria per Cubic Centimeter.
				ALBUMINOID.							
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.		
1,230,000	3.7	.75	1.2584	.3327	.1929	.5621	12.38	1.89	.0125	2.10	126,200

Effluent from Filter No. 360 (Section C).

639,300	3.6	.75	1.0468	.3224	.2013	.5235	12.37	2.12	.0086	2.09	136,400

Effluent from Filter No. 360 (Entire Filter).

1,285,000	3.8	.78	1.4983	.3542	.2073	.5741	12.44	1.54	.0166	2.24	169,400

Effluent from Filter No. 361 (2 Feet).

-	4.5	.82	2.3759	.4306	.2903	.7422	12.47	0.46	.0558	2.80	406,800

Effluent from Filter No. 361 (4 Feet).

-	4.3	.80	2.0909	.3901	.2448	.6695	12.46	0.88	.0486	2.49	287,300

Effluent from Filter No. 361 (6 Feet).

-	4.4	.78	1.7070	.3957	.2386	.6704	12.48	1.32	.0438	2.48	254,500

Effluent from Filter No. 361 (Outlet).

1,283,500	4.2	.76	1.6250	.3579	.2168	.6007	12.55	1.46	.0249	2.21	198,100

Effluent from Filter No. 362 (8 Feet 9 Inches Deep).

1,283,500	3.1	.76	1.5109	.2963	.1899	.5180	12.50	1.32	.0212	1.85	144,800

Effluent from Filter No. 391 (8 Feet Deep).

-	2.9	.75	0.8279	.2407	.1458	.4129	14.55	1.66	.0648	1.64	509,200

Effluent from Filter No. 392 (8 Feet Deep).

-	-	.71	1.1158	.5213	.2289	.9891	11.05	2.20	.0707	3.18	288,800

STABILITY OF EFFLUENTS FROM CONTACT AND TRICKLING FILTERS.

Systematic determinations of the putrescibility of the effluents from contact and trickling filters have been continued as in previous years. The results of these tests for the year 1909 were omitted from the last report, and these results, together with those for the current year, are shown in a following table. As stated in previous reports, filters constructed of coarse materials and operated at high rates cannot be expected to yield clear, bright effluents as is the case with sand filters. When properly constructed and operated, however, such filters may produce well-nitrified and nonputrescible effluents, which after clarification by a short period of sedimentation may be disposed of satisfactorily by dilution. Various methods of determining and expressing putrescibility are in use in different laboratories. At the station the procedure has been to note the production of odor or of blackening of the samples in completely filled glass-stoppered bottles during five days' incubation at 80° F. This method is believed to show true putrescibility, that is, putrefaction, and is not influenced by minor reducing actions within the sample, which in many other methods would influence the results.[1]

During both years all of the samples from trickling Filter No. 135 and from secondary Filter No. 363 have been entirely stable, and the effluents from trickling Filters Nos. 136 and 248 and from contact Filter No. 175 have been found to be putrescible or doubtful only at rare intervals. On the other hand, the effluents from the slate contact Filters Nos. 376 and 377 have been putrescible practically all the time, and the effluent from Filter No. 176, which was stopped at the end of 1909 because it was so badly clogged that reducing actions within the filter predominated over nitrification, was either putrescible or of doubtful quality about two-thirds of the time. The effluent from trickling Filter No. 362, constructed of large pieces of rough clinker, was of much better quality as regards stability than was the effluent of its companion filter, No. 361, of the same depth and operated at the same rate, but constructed of somewhat smaller and smoother pieces of broken stone. The effluents from the sections of trickling Filter No. 360 illustrate the effect of varying rates upon stability of the effluent. The figures in the table show that the effluent from the section receiving sewage at the lowest rate, 700,000 gallons per acre daily or less, was stable 80 per cent. of the time during its first year of operation and entirely stable at all times during its second year of operation; while the effluent from the section receiving sewage at the highest rate, 2,000,000 gallons per acre daily or over, was stable only 37 per cent. of the time during the first year and only 69 per cent. of the time during the second year. The effluent from the section of this filter receiving sewage at a rate intermediate between the other two sections yielded an effluent which was more often putrescible than that of the low-rate section, and more often stable than that of the high-rate section. It will be noted that in spite of the improvement in nitrification in Filter No. 222, due to more uniform distribution of the sewage upon the surface, about one-third of the samples of the effluent were putrescible during each year. As stated in previous reports, the Andover settled sewage applied to this filter is very different in character and much more difficult to purify than is the settled Lawrence sewage applied to the filters at the station.

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[1] See Clark and Adams, "Studies of Incubation Tests," Journal American Chemical Society, Vol. 30, p. 1037, 1908.

It has been stated frequently in preceding reports that, while it is theoretically possible to operate sewage filters in such a manner that nonputrescible effluents will be obtained even when the amounts of nitrates present are low, such operation is not practicable, and the experience at Lawrence has been that effluents which were nonputrescible were always highly nitrified, and *vice versa*. The figures in the table give additional confirmation to this opinion. In every case where the nitrates average over two parts per 100,000, all or practically all of the samples were nonputrescible. When the average nitrates were less than two parts but greater than one part per 100,000, with only one or two exceptions, from 10 to 50 per cent. of the samples were putrescible, while those effluents with low average nitrates were putrescible during the greater part of the time.

The results of putrescibility tests during both years are shown in the following table: —

Stability of Effluents from Contact and Trickling Filters.

Contact Filters.

FILTER NO.	1909.				1910.				BOTH YEARS.			
		PER CENT. OF SAMPLES.				PER CENT. OF SAMPLES.				PER CENT. OF SAMPLES.		
	Nitrates.	Putrescible.	Doubtful.	Stable.	Nitrates.	Putrescible.	Doubtful.	Stable.	Nitrates.	Putrescible.	Doubtful.	Stable.
175, ...	1.96	0	2	98	1.78	0	5	95	1.87	0	4	96
176, ...	0.14	45	23	32	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]
376, ...	0.05	73	20	7	0.09	98	0	2	0.07	92	5	3
377, ...	0.13	100	0	0	0.27	100	0	0	0.20	100	0	0

[1] Not operated in 1910.

Stability of Effluents from Contact and Trickling Filters — Concluded.

Trickling Filters.

FILTER No.	1909.				1910.				BOTH YEARS.			
		PER CENT. OF SAMPLES.				PER CENT. OF SAMPLES.				PER CENT. OF SAMPLES.		
	Nitrates.	Putrescible.	Doubtful.	Stable.	Nitrates.	Putrescible.	Doubtful.	Stable.	Nitrates.	Putrescible.	Doubtful.	Stable.
135, ...	2.57	0	0	100	2.68	0	0	100	2.63	0	0	100
136, ...	1.56	16	14	70	1.82	4	2	94	1.69	10	8	82
222, ...	0.81	31	6	63	1.25	13	20	67	1.03	23	18	59
248, ...	2.33	4	2	94	2.06	0	0	100	2.20	2	1	97
360A, ...	0.84	63	0	37	1.14	31	0	69	0.99	50	0	50
360B, ...	1.55	24	0	76	1.89	2	0	98	1.72	14	0	86
360C, ...	1.42	20	0	80	2.12	0	0	100	1.77	10	0	90
360,[1]	1.10	43	0	57	1.54	17	0	83	1.32	33	0	67
361, ...	1.03	42	0	58	1.46	17	2	81	1.25	31	1	68
362, ...	1.09	30	6	64	1.32	2	5	93	1.20	18	6	76
Secondary Trickling Filters.												
363, ...	2.18	0	0	100	2.43	0	0	100	2.30	0	0	100

[1] Entire filter.

REFILTRATION OF EFFLUENTS FROM TRICKLING FILTERS.

Filters Nos. 363 and 371.

Filter No. 363, 1/20000 of an acre in area, is constructed of 4½ feet in depth of pea-size metallurgical coke, and was first put into operation on Nov. 18, 1908. This filter has been operated as a trickling filter, and has received the effluents from Filters Nos. 135 and 136 at a rate of 4,000,000 gallons per acre daily seven days each week, these effluents being first clarified by sedimentation. Operating with effluents which were stable and well nitrified, this filter accomplished a still further reduction in the organic matters, and continued the nitrification so well begun in the primary filters.

Filter No. 371, 1/80000 of an acre in area, and constructed of 2 feet in depth of sand of an effective size of 0.23 millimeter, was first put into operation on May 20, 1909, and was continued in operation until Oct. 31, 1910. The combined effluents from Filters Nos. 361 and 362 have been passed through a settling tank having a capacity of about five and one-half hours' flow and then applied to this filter at a rate of 10,000,000 gallons per acre daily throughout the year. This filter has been operated continuously, much like continuous water filters, except that when clogged the whole body of sand in the filter has been washed in place by an upward current of water from below. The filter was washed sixty-eight times during the year, the average quantity of water filtered between washings being about 39,000,000 gallons per acre.

The results obtained with this filter and settling tank furnish an interesting illustration of the further purification of trickling filter effluents by natural means. The nearly stable worked-over suspended matters coming from the trickling filters settle out readily in the settling tank, but these suspended matters were capable of further fermentation and disintegration as is shown by the fact that during the warm months, in spite of the frequent removal of sludge, there was some floating scum on the tank, with a certain amount of gas formation. This fermentation must not be confused with putrefaction, however, as no appreciable odors were produced. The clarification begun in the settling tank was completed in the filter, and the final effluent never contained more than a slight turbidity. The purification process going on in the settling tank and in the filter was the reverse of nitrification, the nitrates serving as the source of oxygen for further oxidation of the soluble matters. This is evident by the reduction in the amount of nitrates and increase in the nitrites and free ammonia in the applied effluents in their passage through the settling tank and through the filter. This was in a measure a retrograde process, but is undoubtedly the process taking place when such trickling filter effluents flow into water low in dissolved oxygen. The amount of nitrates remaining in the effluent, and the fact that this effluent always contained an appreciable amount of dissolved oxygen, ensured a complete stability at all times, and this fact was confirmed by negative putrescibility tests throughout the year.

The average analyses of the settled trickling filter effluents applied and of the effluents from these two secondary filters are shown in the following tables: —

Average Analyses.

Settled Trickling Filter Effluent applied to Filter No. 363.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as		Oxygen consumed.	Bacteria per Cubic Centimeter.
				Albuminoid.							
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.		
-	2.2	.72	0.9367	.1768	.1248	.3066	12.15	1.79	.0330	1.49	94,900
Effluent from Filter No. 363.											
3,741,500	1.3	.55	0.3728	.1518	.0829	.2539	11.86	2.43	.0031	1.37	26,500
Settled Trickling Filter Effluent applied to Filter No. 371.											
-	1.7	.76	1.9917	.1795	.1456	-	12.71	1.16	.0433	1.33	616,100
Effluent from Filter No. 371.											
8,771,500	0.6	.71	1.9019	.1160	-	-	12.39	0.89	.0482	1.07	447,900

EXPERIMENTS ON THE PURIFICATION OF MANUFACTURAL WASTES.

Woolen Mill Wastes. — Filter No. 387.

On Dec. 14, 1909, Filter No. 387, containing 3½ feet in depth of sand of an effective size of 0.58 millimeter, was started at a rate of 500,000 gallons per acre daily, with mixed wastes from woolen mill No. 1, from which the wool-scouring liquors were excluded. These wastes, without the wool-scourings, were frequently acid, due to the acid in the shoddy waste. Up to March 25, 1910, this acidity was neutralized with sodium carbonate before the liquor was applied to the filter, and after that date sufficient wool-scourings were added to make the wastes alkaline. This filter became clogged rapidly and frequent scraping was necessary in order to keep it in operation. On September 8 all the sand was removed and the filter refilled with new sand, and operated as before until October 31, when the experiment was discontinued. The amount and composition of the sand removed up to the time the filter was rebuilt are shown in the following table: —

[Parts per 100,000.]

1910.	Amount removed (Inches).	AMMONIA.		Fats.
		Free.	Albuminoid.	
March 8,	4	0.58	20.4	454
March 15,	2	0.90	18.4	345
April 27,	2½	0.90	14.3	608
May 19,	2	1.20	19.3	502
July 8,	2	0.80	19.3	396
August 23,	2	0.90	28.5	476
September 2,	3	-	-	-
September 8,[1]	-	-	-	-
Average,	-	0.40	17.4	253

[1] Filter emptied.

The average analyses of the wastes before and after treatment by Filter No. 387 were as follows: —

Average Analysis of Liquor applied to Filter No. 387.

[Parts per 100,000.]

SOLIDS.			AMMONIA.		NITROGEN AS		Oxygen consumed.
Total.	Loss on Ignition.	Fixed.	Free.	Albumi-noid.	Nitrates.	Nitrites.	
160.9	34.2	126.7	.7194	.3284	-	-	5.13

Average Analysis of Effluent from Filter No. 387.

-	-	-	.6147	.2113	.03	.0010	3.40

Filter No. 388, containing 3½ feet in depth of sand of an effective size of 0.26 millimeter, was started on Dec. 14, 1909, the effluent from Filter No. 387 being applied at a rate of 150,000 gallons per acre daily. On Sept. 12, 1910, the rate was reduced to 75,000 gallons per acre daily. This filter was discontinued on Nov. 1, 1910. The effluent from this filter, although colored by the dyes in the applied wastes, was clear and odorless at all times and at times was well nitrified. No trouble was experienced with clogging at any time, and when the filter was stopped, the sand was clean and the filter could have been continued in operation had it been desired. Analyses of the sand in the filter when it was discontinued were as follows: —

[Parts per 100,000.]

Depth.	Ammonia.		Fats.
	Free.	Albuminoid.	
Average 6 inches,	.24	2.67	20.8
Average of rest of filter,	.26	2.45	10.8

The average analysis of the effluent from this filter follows: —

[Parts per 100,000.]

Ammonia.		Nitrogen as		Oxygen consumed.
Free.	Albuminoid.	Nitrates.	Nitrites.	
.4281	.0826	.20	.0028	1.48

Earlier experiments with the wastes from this mill indicated that with ample settling tanks and separate treatment of the wool-scourings to remove fatty matters, a sand filter or strainer operated at a rate of 500,000 gallons per acre daily would yield a well-clarified effluent which might be readily disposed of by dilution, without nuisance. The present experiments confirm this, and emphasize the necessity of the removal of fatty matters before filtration. These experiments also show that the effluent from such a strainer may be readily purified by filtration through sand at a rate of 100,000 gallons per acre daily or over without any difficulty.

Experiments with Tannery Wastes.

Filters Nos. 372, 373 and 375 were put into operation on June 1, 1909, and continued in operation during the first three months of 1910, in a study of the purification of the supernatant waste from the settling tanks at Tannery C. This supernatant waste as received still contained a considerable amount of suspended matters, and these were removed by additional settling as far as possible before the waste was applied to the filters. Filter No. 372 contained 6 feet in depth of broken stone of such size that all would pass through a ring 1 inch in diameter and none through a ring ½ inch in diameter. Filters Nos. 373 and 375 each contained 3½ feet in depth of sand of an effective size of 0.26 millimeter.

Filter No. 372 was operated as a trickling filter, the settled waste being applied at rates varying between 500,000 and 1,500,000 gallons per acre daily, the aim being to operate the filter at the highest possible rate and still obtain fair nitrification within the filter. The average rate of operation was 867,000 gallons per acre daily. The effluent from this filter was well nitrified, stable and practically odorless throughout, and resembled in appearance the effluents from other trickling filters operated with sewage.

The effluent from Filter No. 372 was settled and applied to secondary Filter No. 375 at an average rate of about 70,000 gallons per acre daily. The resulting effluent was always well nitrified, stable and odorless, but at times was slightly turbid.

Filter No. 373 was operated as an intermittent filter, receiving the settled waste at an average rate of about 135,000 gallons per acre daily. In appearance the effluent from this filter was similar to that from trickling Filter No. 372, except that the color was slightly higher. Nitrification was active in the filter at all times, the nitrates in the filter effluent averaging about 6 parts per 100,000.

All these filters were kept in operation without difficulty and were in good condition at the end of the experiment. It is evident from these experiments that the wastes from this tannery, if properly clarified, can be easily purified by trickling filters operated at rates of from 500,000 to 1,000,000 gallons per acre daily, and that a very satisfactory purification can be accomplished by intermittent filtration through sand at a rate of 70,000 gallons per acre daily, or by refiltration of the trickling filter effluents through sand at rates of 100,000 to 150,000 gallons per acre daily.

The average analyses of the effluent from the tannery settling tanks as received, of the waste after further settling and of the effluents from these three filters are shown in the following table: —

Average Chemical Analyses, May, 1909, to August, 1910, inclusive.

Effluent from Settling Tanks as received from Tannery.

[Parts per 100,000.]

Color.	AMMONIA.			NITROGEN AS		Oxygen consumed.	Hardness.	Fats.
	Free.	ALBUMINOID.						
		Total.	In Solution.	Nitrates.	Nitrites.			
-	4.33	2.96	2.52	-	-	18.35	138.40	16.70

Resettled Waste as applied to Filters Nos. 372 and 373.

-	4.46	2.62	-	-	-	15.27	-	-

Average Chemical Analyses, May, 1909, to August, 1910, inclusive — Concluded.

Effluent from Filter No. 372.

[Parts per 100,000.]

Color.	Ammonia.			Nitrogen as		Oxygen consumed.	Hardness.	Fats.
	Free.	Albuminoid.						
		Total.	In Solution.	Nitrates.	Nitrites.			
1.41	2.42	0.93	0.47	2.33	.0824	5.01	-	–

Effluent from Filter No. 373.

0.70	0.92	0.12	-	5.97	.0184	1.18	-	–

Effluent from Filter No. 375.

0.80	0.60	0.16	-	4.26	.0148	1.32	-	-

REMOVAL OF BACTERIA BY SEWAGE PURIFICATION SYSTEMS.

In the following table are shown the average numbers of bacteria as determined on agar plates incubated four days at 20° C., and of the total and red colonies on litmus lactose agar plates incubated eighteen hours at 40° C. The significance of these different counts has been discussed frequently in preceding reports. All of the intermittent sand filters show a removal of over 99 per cent. of all types of bacteria. Contact Filter No. 175 removed about 37 per cent. of the total bacteria from the strained sewage and about 49 per cent. of the types of bacteria developing at body temperature. Of the two slate filters, the one operated with Lawrence regular sewage showed a bacterial efficiency of less than 50 per cent. based on the total counts, and less than 25 per cent. based on the body temperature counts, while the one operated with settled fresh sewage showed a removal of about 46 per cent. of the body temperature types, but the total numbers of bacteria in its effluent were greater than in the applied sewage.

The removal of bacteria by the older trickling Filters Nos. 135 and 136 was somewhat greater than that by the other trickling filters, and the bacterial efficiencies of trickling filters located at the station were much better than of those located at Andover. The work of Filter No. 135, with a removal of over 98 per cent. of all types of bacteria, was particularly satisfactory. The effect of varying rates is well illustrated by the body temperature results on the different sections of Filter No. 360, the bacterial efficiency being greatest on the section operated at the lowest rate and lowest on the section receiving sewage at the highest rate. The progressive purification accomplished as sewage passes through a trickling filter is well illustrated by the results of analyses of samples collected from the different levels of Filter No. 361. Of the two secondary filters, Filter No. 363, constructed of pea-size coke and operated as a trickling filter, was much more efficient bacterially than Filter No. 371, which was constructed of sand and operated in the same manner as water filters are operated.

Of the various methods of preliminary clarification of sewage, the coal strainer was more efficient in removing bacteria than were either of the settling tanks, and the settling tank at Andover was somewhat more efficient than the settling tank operated with Lawrence sewage. The difference in efficiency between these two settling tanks is relatively small, however, and may be partly accounted for by the fact that the suspended matters in the sewage entering the tank at the station are much more finely divided than is the case with that entering the Andover tank.

Table showing Removal of 20° and 40° C. Bacteria by Sewage Filters.

	BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF BACTERIA REMOVED.		
	20° C.	40° C.		20° C.	40° C.	
		Total.	Red.		Total.	Red.
Lawrence street sewage,	1,507,300	400,700	302,600	-	-	-
Regular sewage,	2,095,600	448,100	363,600	-	-	-
Settled sewage,	1,386,300	254,900	207,900	33.80	43.00	42.90
Effluent, Strainer E,	874,200	141,900	115,800	58.50	68.40	68.20
Andover regular sewage,	3,476,100	646,500	539,200	-	-	-
Andover settled sewage,	1,461,800	360,600	271,400	58.00	44.30	49.70
Fresh sewage,	3,241,600	597,700	553,000	-	-	-
Effluent, Imhoff tank,	1,730,000	343,200	189,200	46.60	42.60	65.80
Effluent, sand filter: —						
No. 1,	6,200	4,300	3,800	99.71	90.04	98.96
2,	975	39	17	99.95	99.99	99.99
4,	195	42	33	99.99	99.99	99.99
5C,	5,600	3,200	2,440	99.73	99.29	99.33
6,	2,160	760	590	99.90	99.83	99.84
9A,	1,290	384	252	99.94	99.91	99.93
10,	2,565	470	400	99.88	99.90	99.89
Effluent, contact filter: —						
No. 175,	553,300	74,100	60,100	36.70	47.90	48.10
376	1,105,600	342,400	290,300	47.20	23.70	20.30
37,	2,123,500	184,700	129,800	-	46.00	31.20

Table showing Removal of 20° and 40° C. Bacteria by Sewage Filters—Concluded.

	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.		
	20° C.	40° C.		20° C.	40° C.	
		Total.	Red.		Total.	Red.
Effluent, trickling filter: —						
No. 135,	22,300	4,030	2,970	98.40	98.42	96.58
136,	70,800	10,100	8,300	94.91	96.04	96.01
222,	256,000	22,800	20,000	82.50	93.70	92.60
248,	287,800	43,900	33,800	79.30	82.80	83.75
360A,	206,700	20,200	15,200	85.10	92.08	92.69
360B,	141,800	16,100	12,300	89.80	93.69	94.09
360C,	158,300	13,000	9,700	88.70	94.90	95.35
360 (entire),	169,400	17,700	13,300	87.90	93.06	93.60
361 (2 feet),	406,800	41,700	32,400	70.70	83.70	84.40
361 (4 feet),	287,300	26,000	20,100	79.40	89.80	90.34
361 (6 feet),	254,500	18,200	13,700	81.70	92.85	93.42
361 (outlet),	198,100	20,000	15,400	85.80	92.15	92.59
362,	144,800	22,700	18,600	89.60	91.10	91.05
391,	509,200	78,400	50,800	63.40	69.40	75.60
392,	288,800	23,400	17,300	80.20	93.50	93.60
Secondary filter: —						
No. 363,	26,500	2,500	2,000	72.00	60.30	48.70
371,	447,900	10,900	7,850	27.40	46.80	48.40

PURIFICATION OF WATER.

During 1910 studies on the purification of polluted water by slow sand filtration, by double filtration, and by mechanical filters with the aid of coagulants, and systematic studies on the relative efficiency of filters of equal depths and containing sand of the same effective size but operated at different rates, have been continued. The studies of disinfection in connection with the operation of water filters, reported last year, have also been continued during the present year, and many additional data as to the practicability and efficiency of this combination of processes have been obtained. In addition, studies have been begun on the preliminary clarification of water by upward filtration through a roughing filter of coarse gravel, and on the purification of water by a sand filter to which the water is applied at frequent intervals in small doses in much the same way that sewage is applied to sprinkling or trickling filters. As in previous years, special attention has been paid to the work of the filters which purify the water supply of the city of Lawrence, and the results obtained with these filters, operated on a practical scale, afford a valuable check upon the results of experimental filters operated at the station.

LAWRENCE CITY FILTERS.

The city of Lawrence has two filters. The older filter was constructed in 1893, and dividing walls separating it into three sections were built in 1902. The average depth of sand in this filter is about 4 feet and the net filtering area, after deducting division walls, gate-chambers and lateral carriers, is about 2.2 acres. As originally constructed, this filter contained two different grades of sand, the portions of the filter immediately over the underdrains being of finer sand than the remainder of the filter. Through the operations of scraping, washing and replacing sand, the two grades of sand have become quite thoroughly mixed in the upper layers of the filter, and at the present time this upper sand has an effective size of approximately 0.25 millimeter. This filter is not covered, and has an earth bottom through which some ground water finds its way into the underdrains and becomes mixed with the filtered water. Its average rate of operation during the past few years has been about 1,250,000 gallons per acre daily.

During 1906 and 1907 an additional filter was constructed to supplement the supply of filtered water from the old filter. This filter, which is of concrete construction, has a tight bottom and is covered, is ¾ of an acre in area and contains about 4½ feet of sand of an effective size of 0.25 millimeter. It was first put into operation on Nov. 4, 1907, but the filtered water was not used until Jan. 4, 1908. The rate of operation followed has been about 3,000,000 gallons per acre daily. The effluents from both filters flow into the same pump-well, from which they are pumped into the distributing reservoir.

Comparing the results obtained with these two filters during the year, it will be noted that the effluent from the new filter contained slightly less color and less than one-fourth as much iron than the effluent from the old filter. Otherwise, the two effluents were of about the same chemical quality. As in previous years, the character of the filtered water improved materially from a chemical point of view as it passed through the reservoir and distributing system of the city.

The bacterial efficiency of the new filter has never been so great as that of the old filter. This is probably due in part to the much lower rate of operation of the old filter. The average bacterial content of the Merrimack River water applied to these filters during 1910 was 9,100 per cubic centimeter; the effluent from the old filter contained on an average 57 per cubic centimeter and the effluent from the new filter 115 per cubic centimeter; the average removal of bacteria by the old filter being 99.4 per cent., and by the new filter 98.7 per cent. B. coli were found in 1 cubic centimeter in about twice as many samples of the effluent from the new filter as in the effluent from the old filter.

The results of analyses of the Merrimack River as it flows to the filters, of the effluents from both filters, and of the mixed effluents as pumped into the distributing reservoir, and after passage through that reservoir to various points in the distribution system, are shown in the following tables: —

Average Chemical Analyses.

Merrimack River. — Intake of the Lawrence City Filter.

[Parts per 100,000.]

Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Iron.	Hardness.
				ALBUMINOID.							
	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.			
51	0.5	.38	.0196	.0233	.0185	.44	.014	.0006	.61	.0721	1.2

Average Chemical Analyses — Concluded.

Effluent from the Lawrence City Filter (Old Filter).

[Parts per 100,000.]

Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Iron.	Hardness.
				ALBUMINOID.							
	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.			
52	0.0	.35	.0133	.0103	-	.48	.031	.0003	.45	.1342	1.6
Effluent from the Lawrence City Filter (New Filter).											
51	0.0	.30	.0068	.0110	-	.44	.022	.0001	.49	.0297	1.2
Water from the Outlet of the Distributing Reservoir.											
51	0.1	.37	.0073	.0104	-	.48	.034	.0003	.42	.0913	1.5
Water from a Tap at Lawrence City Hall.											
52	0.1	.43	.0057	.0107	-	.48	.033	.0004	.41	-	1.5
Water from a Tap at the Lawrence Experiment Station.											
53	0.0	.36	.0045	.0094	-	.48	.034	.0001	.39	-	1.5

Average Bacterial Analyses.

Merrimack River. — Intake of the Lawrence City Filter.

BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF BACTERIA REMOVED.			PER CENT. OF SAMPLES CONTAINING B. COLI.	
20° C.	40° C.		20° C.	40° C.			
	Total.	Red.		Total.	Red.	1 c. c.	100 c. c.
9,100	265	140	-	-	-	100.0	100.0
Effluent from the Lawrence City Filter (Old Filter).							
57	5	2	99.4	98.1	98.6	8.3	68.5
Effluent from the Lawrence City Filter (New Filter).							
115	10	4	98.7	96.2	97.1	16.6	73.1

Average Bacterial Analyses — Concluded.

Mixed Effluents as Pumped to Distributing Reservoir.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.	
20° C.	40° C.		20° C.	40° C.			
	Total.	Red.		Total.	Red.	1 c.c.	100 c.c.
74	6	2	-	-	-	7.8	70.8

Water from the Outlet of the Distributing Reservoir.

38	4	2	-	-	-	6.0	58.9

Water from a Tap at Lawrence City Hall.

48	5	1	-	-	-	2.3	61.9

Water from a Tap at the Lawrence Experiment Station.

33	4	1	-	-	-	2.0	56.9

SLOW SAND FILTERS. — FILTERS NOS. 8A AND 343.

Filter No. 8A, $\frac{1}{200}$ of an acre in area, and first put into operation on Sept. 26, 1893, contained about 32 inches in depth of sand of an effective size of 0.28 millimeter at the beginning of 1910. The average rate of operation was 2,871,000 gallons per acre daily. This filter was scraped fourteen times during the year, the average amount of water filtered between scrapings being about 61,500,000 gallons per acre.

Filter No. 343, $\frac{1}{20000}$ of an acre in area, containing 40 inches in depth of sand of an effective size of 0.35 millimeter, was first put into operation on March 27, 1908. The average rate of operation during 1910 was 4,927,000 gallons per acre daily. The surface of the filter was washed twenty-two times during the year, the average amount of water filtered between washings being about 77,000,000 gallons per acre. On October 21, for experimental purposes, 6 inches of sand were removed from the surface of the filter and the remaining sand dug over to a depth of 6 inches.

The average number of bacteria in the effluent from Filter No. 8A was 38 per cubic centimeter during the year, and in the effluent from Filter No. 343 was 80 per cubic centimeter. The average bacterial efficiencies of these two filters were 99.3 per cent. for Filter No. 8A, and

98.6 per cent. for Filter No. 343. B. coli were found in 1 cubic centimeter in about one-fourth of the samples of the effluent from Filter No. 343, and in about 22 per cent. of the samples collected from Filter No. 8A.

The average analyses of the effluents from these filters are shown in the following tables: —

Average Chemical Analyses.

Effluent from Filter No. 8A.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
2,571,200	54	0.0	.28	.0061	.0107	.50	.030	.0006	.48	25.0	1.1
Effluent from Filter No. 343.											
4,927,000	54	0.0	.30	.0069	.0116	.47	.023	.0007	.49	31.3	1.2

Average Bacterial Analyses.

Effluent from Filter No. 8A.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
38	6	2	99.3	96.5	98.0	22.2
Effluent from Filter No. 343.						
80	8	3	98.6	95.3	97.0	25.6

Studies on the Relative Efficiency of Slow Sand Filters operated at Different Rates.

Filters Nos. 220, 244, 281 and 330, each containing about 40 inches in depth of sand of an effective size of 0.20 to 0.24 millimeter, were continued in operation during the first ten months of the year. Filter No. 330 was operated at an average rate of 4,859,000 gallons, Filter No. 220

at an average rate of 6,775,000 gallons, Filter No. 281 at an average rate of 6,890,000 gallons, and Filter No. 244 at an average rate of 15,352,000 gallons per acre daily. The surface of Filter No. 330 was washed to a depth of 1 inch to relieve clogging twenty-five times; that of Filter No. 281, forty times; that of Filter No. 220, fifty-seven times; and that of Filter No. 244, fifty-seven times during the period of ten months they were operated during the year. In addition to washing the surface, it was necessary to scrape Filter No. 330 twice, Filter No. 281 once, Filter No. 220 three times, and Filter No. 244 four times, and to wash the whole body of sand in Filters Nos. 220 and 244 twice each. As stated in the report of operation of these filters during 1908 and 1909, the filters were of different ages when the experiment upon comparative rates was begun, and for this reason the comparison has hardly been a fair one. It was intended to operate Filter No. 220 at a higher rate (approximately 10,000,000 gallons per acre daily) than Filter No. 281. Owing to serious clogging within the lower layers of sand in this filter, which could not be removed except by rebuilding the filter, the high rate of operation could not be maintained, and the experiment was discontinued on Sept. 30, 1910.

From a bacterial viewpoint, the effluent from Filter No. 281 was of better quality than that from Filter No. 330, which was operated at a lower rate, or than that from Filter No. 220, which was operated at much the same rate. The effluent from Filter No. 244, which was operated at a much higher rate, contained on an average 295 bacteria per cubic centimeter, and showed a bacterial efficiency of less than 95 per cent., a result much poorer than those obtained with the other three filters operating at lower rates.

The average analyses of the effluents from these filters are shown in the following tables: —

Average Bacterial Analyses.

Canal Water (Merrimack River Water).

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
5,600	175	104	-	-	-	100.0
Effluent from Filter No. 220.						
53	8	2	99.0	95.3	97.0	28.9

Average Bacterial Analyses — Concluded.

Effluent from Filter No. 244.

BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF BACTERIA REMOVED.			PER CENT. OF SAMPLES CONTAINING B. COLI.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
295	17	9	94.7	90.0	91.0	45.7
Effluent from Filter No. 281.						
28	5	1	99.5	97.1	99.0	17.7
Effluent from Filter No. 330.						
95	6	2	98.3	96.5	98.0	19.6

Average Chemical Analyses.

Canal Water (Merrimack River Water).

[Parts per 100,000.]

Quantity applied. Gallons per Acre Daily.	Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
					ALBUMINOID.							
		Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.			
-	54	0.2	.38	.0214	.0206	.0173	.48	.015	.0006	.61	68.8	1.3
Effluent from Filter No. 220.												
6,774,600	56	0.0	.30	.0050	.0110	-	.42	.023	.0003	.50	36.1	1.2
Effluent from Filter No. 244.												
15,351,900	56	0.0	.31	.0088	.0128	-	.45	.028	.0004	.52	43.9	1.1
Effluent from Filter No. 281.												
6,890,400	56	0.0	.32	.0060	.0114	-	.43	.023	.0002	.54	27.9	1.1
Effluent from Filter No. 330.												
4,856,600	59	0.0	.32	.0045	.0114	-	.43	.020	.0005	.54	30.2	1.2

MECHANICAL FILTRATION COMBINED WITH DISINFECTION.

Filter No. 336, $\frac{1}{40000}$ of an acre in area, and containing 24 inches in depth of sand of an effective size of 0.35 millimeter, was first put into operation on Dec. 11, 1907. This filter has been operated as a mechanical filter at a rate of 100,000,000 gallons per acre daily with canal water which has been treated with sulphate of alumina and a mixture of soda ash and hypochlorite of lime, and passed through a settling tank with a storage capacity of three and one-fourth hours. In the report for 1909 it was proved that in order to obtain an effluent containing low numbers of bacteria, the use of about 2.0 grains sulphate of alumina and 1.5 grains soda ash per gallon are necessary, but that by the addition of small amounts of a disinfectant such as hypochlorite of lime an effluent of low bacterial content and of satisfactory physical appearance can be produced by the use of about 1.0 grain sulphate of alumina and 0.75 grain soda ash per gallon.

For purposes of comparison, the filter was operated during one day in each week without the addition of the disinfectant The average number of bacteria in the effluent of the coagulation and settling basin on the days when no disinfectant was added was 530 per cubic centimeter, and the average number in the effluent from the filter was 95 per cubic centimeter, the bacterial efficiency of the settling tank being about 93 per cent., the efficiency of the filter being about 82 per cent. and the efficiency of the system being about 98.3 per cent. The average number of bacteria in the effluent from the settling basin during the remainder of the time, when disinfectant was being added, was 22 per cubic centimeter, and the number in the filter effluent was 13 per cubic centimeter, the average bacterial efficiency of the process of coagulation and sedimentation combined with disinfection being 99.6 per cent., the removal of bacteria by the filter being about 41 per cent. and the efficiency of the system being about 99.8 per cent. It will be observed that the bacterial efficiency of the settling tank under the combined process was greater than the efficiency of the entire system on the days when no disinfectant was added. In other words, as was pointed out in the last report, the filter in this case acted as a very large factor of safety, ensuring an effluent of low bacterial content.

Chemically, the effluent from this filter was of satisfactory quality throughout the year, the water being free from turbidity and having an average color of 0.13. The removal of color was about 66 per cent., and the removal of organic matter was 48 per cent. and 51 per cent., as shown by albuminoid ammonia and oxygen consumed determinations, respectively.

The average amounts of coagulants added during 1910 have been 0.97 grain sulphate alumina and 0.62 grain soda ash per gallon, and the amount of disinfectant used has averaged about 0.15 grain per gallon, equivalent to 0.096 part per 100,000 available chlorine. With sulphate of alumina and soda ash each at 1 cent per pound, and bleaching powder, averaging 37 per cent. available chlorine, at 1¼ cents per pound, the cost for chemicals averaged about $2.55 per million gallons.

The average quantity of water filtered between washings was about 30,000,000 gallons per acre, the average length of time the filter could be operated without washing being about seven hours ten minutes.

The average results of the operation of this filter are shown in the following tables: —

Average Bacterial Analyses.

Canal Water (Merrimack River Water).

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
5,600	170	100	-	-	-	100.0
Effluent from Coagulation Basin (with Disinfectant).						
22	10	2	99.6	94.1	98.0	2.6
Effluent from Coagulation Basin (without Disinfectant).						
530	27	15	90.5	84.6	85.6	41.3
Effluent from Filter No. 336 (with Disinfectant).						
13	2	-	40.9	80.0	100.0	0.8
Effluent from Filter No. 336 (without Disinfectant).						
95	2	1	82.1	92.6	93.3	12.8
Bacterial Efficiency of Entire System.						
-	-	-	99.8	99.8	100.0	-

Average Chemical Analyses.

Canal Water (Merrimack River Water).

[Parts per 100,000.]

Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
				ALBUMINOID.							
	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.			
54	0.2	.38	.0214	.0206	.0173	.48	.015	.0006	.61	68.8	1.3

Effluent from Coagulation Basin.

Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
				ALBUMINOID.							
	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.			
54	0.4	.25	.0232	.0211	-	.73	.016	.0002	.47	67.5	1.1

Effluent from Filter No. 336.

Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
				ALBUMINOID.							
	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.			
55	0.0	.13	.0219	.0107	-	.72	.016	.0004	.30	75.4	1.0

DOUBLE FILTRATION COMBINED WITH DISINFECTION.

Filters Nos. 331 and 286.

Filter No. 331, 1/80000 of an acre in area, containing 18 inches in depth of sand of an effective size of 0.45 millimeter, and first put into operation on July 7, 1907, has been operated as a pre-filter at a rate of 50,000,000 gallons per acre daily throughout the year. The canal water applied to this filter is first passed through a settling basin having a storage capacity of about ten hours. The entire body of sand in the filter was washed in the same way that mechanical filters are washed, thirty-four times during the year, the average quantity of water filtered between washings being about 520,000,000 gallons per acre. The effluent from Filter No. 331 flows into a tank where it is treated with hypochlorite of lime, and, after about thirty minutes' storage, is pumped into a storage tank from which it is applied to Filter No. 286. The average amount of hypochlorite of lime added was about 0.076 grain per gallon, equivalent to about 0.048 part available chlorine per 100,000. The average cost of chemicals, with bleaching powder containing 37 per cent. available chlorine at 1¼ cents per pound, was about 45 cents per million gallons.

Filter No. 286, 1/20000 of an acre in area, containing 4 feet in depth of sand of an effective size of 0.21 millimeter, was first put into operation on Jan. 20, 1906. This filter has been operated as a secondary filter with the treated effluent from Filter No. 331, at a rate of 5,000,000 gallons per acre daily. The surface of this filter was scraped twice during the year, the average quantity of water filtered per scraping being about 780,000,000 gallons per acre. The net rate of the double filtration system was about 4,550,000 gallons per acre daily.

From a chemical and physical viewpoint, the effluent from this double filtration system was of about the same quality as effluents from single filters operated at about the same net rates. The color of the canal water was reduced about 10 per cent. and the albuminoid ammonia about 50 per cent., during passage through both filters. The amount of nitrates in the water was about doubled during filtration and the free ammonia was decreased about 70 per cent. About 50 per cent. of the bacteria were removed from the canal water by passage through the settling tank before being applied to Filter No. 331. The average removal of bacteria by Filter No. 331 was about 47 per cent. The result of the disinfection process was a removal of about 86 per cent. of the bacteria as shown by room temperature counts, and about 65 per cent. as shown by body temperature counts. In the tank in which the treated effluent was stored before being applied to the secondary filter the numbers of bacteria increased about 120 per cent. as shown by room temperature counts, but there was no increase in the numbers as shown by the body temperature counts. The average bacterial efficiency of the secondary filter was about 86 per cent. as shown by the room temperature counts, and about 50 per cent. as shown by body temperature counts, a very satisfactory result considering the low numbers of bacteria in the water applied to this filter. The average efficiency of the entire system computed from the averages of the effluent from the secondary filter and from the canal water before entering the settling tank was about 98.8 per cent., or slightly less than that of Filters Nos. 220, 281 and 330, previously discussed, each of which was operated at a somewhat higher rate, and in each of which the water received only a single filtration, without any disinfection treatment.

The average chemical and bacterial analyses of the water at various stages through this system of double filters are shown in the following tables: —

Average Chemical Analyses.

Canal Water (Merrimack River Water).

[Parts per 100,000.]

Quantity applied. Gallons per Acre Daily.	Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	ALBUMINOID. Total.	ALBUMINOID. In Solution.		Nitrates.	Nitrites.			
-	54	0.2	.38	.0214	.0206	.0173	.48	.015	.0006	.61	68.8	1.3
Effluent from Primary Filter No. 331.												
50,632,500	57	0.1	.37	.0138	.0167	-	.49	.024	.0006	.57	42.5	1.2
Effluent from Secondary Filter No. 286.												
5,213,000	57	0.0	.30	.0067	.0111	-	.63	.030	.0002	.48	53.7	1.3

Average Bacterial Analyses.

Canal Water (Merrimack River Water).

BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF BACTERIA REMOVED.			PER CENT. OF SAMPLES CONTAINING B. COLI.
20° C.	40° C. Total.	40° C. Red.	20° C.	40° C. Total.	40° C. Red.	1 c. c.
5,600	170	100	-	-	-	100.0
Settling Tank Effluent applied to Filter No. 331.						
2,810	123	74	49.9	27.5	26.0	100.0
Effluent from Pre-Filter No. 331 (before Disinfection).						
1,480	48	30	47.3	61.0	59.5	100.0
Effluent from Pre-Filter No. 331 (after Disinfection).						
210	17	7	85.8	64.6	76.7	11.6
Stored Effluent as applied to Secondary Filter No. 286.						
460	18	6	120.0[1]	5.9[1]	14.3	30.5

[1] Increase.

Average Bacterial Analyses — Concluded.

Effluent from Secondary Filter No. 286.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
66	9	3	85.7	50.0	50.0	12.8

Bacterial Efficiency of Entire System.

-	-	-	98.8	94.7	97.0	-

CLARIFICATION BY UPWARD FILTRATION THROUGH A ROUGHING FILTER OF COARSE MATERIAL.

Filter No. 389.

In the last report, studies of upward filtration at a high rate through a filter of sand overlying a layer of charcoal were reported, and it was shown that extreme difficulty was experienced in keeping such a filter in operation, owing to the accumulation of clogging matters in the lower layers, which clogging could not be removed either by reversing the flow or by washing the filter material in place. In order to determine whether a filter of coarser material and operated at a lower rate could be successfully operated in this manner, Filter No. 389, $\frac{1}{20000}$ of an acre in area, was put into operation on April 14, 1910. This filter contained 6 inches in depth of wood charcoal supported upon a $\frac{1}{4}$-inch mesh galvanized wire screen placed 12 inches above the bottom of the tank. Overlying the charcoal, and separated from it by a $\frac{1}{8}$-inch mesh copper screen, was placed 24 inches in depth of broken stone pebbles, of an effective size of 4.4 millimeters. Canal water entered at the bottom, passed upward through the filter material and overflowed through an orifice placed 3 inches above the surface of the stone. This filter has been operated at a rate of about 10,000,000 gallons per acre daily, the rate of flow being controlled at the outlet. As constructed, the available loss of head is about 10 inches. On October 6, or after about six months' operation, the filter had become so clogged that the prescribed rate could not be maintained, and the filter was then washed by reversing the flow for a few minutes. This washing was successful in removing the clogging, and the filter was operated without further treatment during the remainder of the year.

This filter, constructed of such coarse material and operated at this high rate, cannot be considered as other than a roughing filter to prepare the water for ultimate treatment by some other process. From this viewpoint the work of the filter was very satisfactory. Practically all of the suspended matters were removed, the color was reduced about 12 per cent. and the organic matter was reduced about 33 to 35 per cent. as shown by oxygen consumed and albuminoid ammonia determinations, respectively, while the nitrates were increased about 67 per cent. The monthly averages of bacteria varied between 130 and 1,760 per cubic centimeter, averaging 860 per cubic centimeter during the year. The average removal of bacteria was about 85 per cent. as shown by counts at room temperature, and about 82 per cent. as shown by body temperature counts. Comparing the work of this filter with that of pre-filter No. 331, constructed of sand, but operated at a rate about ten times as great, it will be observed that the effluent from Filter No. 389 was of slightly better quality, both chemically and bacterially, than the effluent from Filter No. 331.

The average chemical and bacterial analyses of the effluent from this filter are shown in the following tables: —

Average Chemical Analyses.

Effluent from Filter No. 389.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
10,087,600	63	0.0	.36	.0089	.0133	.47	.025	.0007	.55	34.2	1.4

Average Bacterial Analyses.

Effluent from Filter No. 389.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
860	31	19	84.7	81.8	81.6	74.1

PURIFICATION OF WATER BY A SPRINKLING FILTER OF SAND.

Filter No. 390, $\frac{1}{20000}$ of an acre in area, and constructed of 54 inches in depth of sand of an effective size of 0.42 millimeter, was first put into operation on April 21, 1910. Canal water was sprinkled upon the surface of this filter by means of a tipping basin discharging into a perforated pan placed 12 inches above the surface. The outlet of the filter was kept wide open at all times, the rate of operation being controlled at the influent pipe, the average rate being 4,143,000 gallons per acre daily. The practice has been to rake the surface of the filter to a depth of 1 inch whenever pooling of the water on the surface occurred. After six months' operation, pooling on the surface could no longer be prevented by surface raking, and on October 21, 3 inches of dirty sand were scraped from the surface and the filter was allowed to rest for one week. Even after this radical treatment almost daily raking was required. Up to the end of the year the filter was actually operated one hundred and seventy-seven days, during which period the surface was raked one hundred and fifty-eight times. Chemically, the effluent from this filter was of better quality than the effluents from Filters Nos. 220, 330 and 343, which were constructed of somewhat finer material and were operated at similar rates. The average removal of color by the filter was about 43 per cent., as compared with a removal of about 23 per cent. by Filters Nos. 220 and 343. The average reduction in albuminoid ammonia was 54 per cent. and the reduction in oxygen consumed was about 30 per cent., while the greatest reductions by the best of the three slow sand filters were 46 per cent. in albuminoid ammonia and 20 per cent in oxygen consumed, respectively. Nitrification was also more active in the sprinkling filter than in any of the comparable slow sand filters, the average amount of nitrates in the effluent being .032 part per 100,000, while the highest average nitrates in the effluents of the other filters were found in the effluent from Filter No. 343, which contained .023 part per 100,000.

The effluent from this filter contained more bacteria than the effluents from the slow sand filters. The average numbers of bacteria varied from 17 per cubic centimeter to 310 per cubic centimeter in different months, the average being 110 per cubic centimeter. The average bacterial efficiency was 98 per cent. In comparison, the numbers of bacteria in the effluents from Filters Nos. 220, 330 and 343 averaged 53, 95 and 80 per cubic centimeter, respectively, the least bacterial removal by any of these three filters being 98.3 per cent. and the maximum removal being 99 per cent. As regards numbers of bacteria growing at body temperature the effluents from both types of filters were quite similar. An interesting feature in the operation of this filter was the comparatively low numbers of bacteria obtained in the effluent from the beginning. With slow sand filters the numbers of bacteria in the effluents, when such filters are first put into operation, are usually as high or higher than the numbers in the applied water, and a period of time ranging from a week to some months is required before such filters come to maturity and the numbers of bacteria decrease to normal. With this filter, however, no maturing period was observed, the numbers of bacteria in the effluent being 360 per cubic centimeter on the first day, 290 on the second day, 144 on the third day and 85 on the fourth day, after which the numbers fluctuated, as previously stated.

From the results quoted it is evident that while something may be gained in the removal of color and organic matter by the use of a filter of this type, the diminished bacterial efficiency, and especially the very frequent surface treatment required to keep the filter in operation, greatly diminish the practicability of filters of this type for use with waters resembling the Merrimack River water.

The average chemical and bacterial analyses of the effluent from this filter are shown in the following tables: —

Average Chemical Analyses.

Effluent from Filter No. 390.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
4,143,400	62	0.0	.23	.0039	.0096	.48	.032	.0001	.43	65.6	1.4

Average Bacterial Analyses.

Effluent from Filter No. 390.

BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF BACTERIA REMOVED.			PER CENT. OF SAMPLES CONTAINING B. COLI.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
110	7	3	98.0	95.9	97.0	19.2

STUDIES OF THE RELATIVE CORROSION OF METAL PIPES BY WATERS, ESPECIALLY BEFORE AND AFTER PURIFICATION.—REVIEW OF LITERATURE ON CORROSION.

By H. W. Clark and Stephen DeM. Gage.

During the years 1896 to 1900, inclusive, extensive investigations were made in the laboratories of the Board in regard to the action of water upon metallic pipes. The cause of these investigations, the results of which were given in the reports for 1898 and 1900, was that many cases of lead poisoning were reported in certain places where lead service pipes were in use. The investigations, therefore, were devoted largely to determinations of the solvent action of certain waters of the State upon such metals as lead, zinc and copper, as such metals, when held in solution in any considerable amounts, may, and in the case of lead do, injuriously affect the health of persons using these waters. During recent years another phase of the corrosion problem has manifested itself, and much complaint has been made that certain waters after purification, especially by coagulants and mechanical filters, are rendered more corrosive in their action upon iron and other pipes, giving rise to so-called "red water troubles," in which the water contains excessive amounts of iron rust. While such waters probably do not — merely on account of containing excessive amounts of iron — cause any injurious effect upon the health of persons using them, they are not satisfactory for laundry and other domestic purposes. During 1910 an investigation of this phase of the corrosion problem was begun, to determine to what extent various methods of water purification were responsible for such "red water troubles," and to devise remedies if possible; and also to determine what effect variations in the composition of natural waters might have on iron and galvanized-iron pipes, and also upon other metals, such as brass, copper, tin, lead, etc., which are used either alone or in contact with one another in plumbing fixtures. These experiments are as yet far from complete. In certain cases, however, sufficient data have been obtained to indicate the effect of certain factors in the action of different classes of water upon iron and galvanized-iron pipes, and to warrant a preliminary report at this time. It should be borne in mind, however, that the results given are comparative only; that the number of different waters experimented with so far is limited, and the results cannot be taken as completely representative of results that might be obtained with other waters of the same general classes.

The general method of making experiments is as follows: for tests with cold water, pipes 1 inch in diameter and 30 feet long, with one coupling at the middle and two elbows, one at either end, are used. One elbow is fitted with a plug and the other with a 6-inch nipple closed with a cap. These pipes are laid with a slight pitch, the top of the plugged elbow and the top of the 6-inch nipple being on the same level. The pipes hold about 1½ gallons of water, and are filled and emptied through the short rising nipple at the lower end. When testing the action of hot water, pipes 1 inch in diameter and about 6 feet long, capped at each end, have been used, these pipes being laid directly upon the top of a steam boiler. The temperature of the water in the large pipes has ranged from 50° to 70° F., while the temperature of the water in the smaller pipes laid on the steam boiler has ranged from 125° to 135° F. The practice has been to empty and refill each pipe generally at intervals of seven days during those experiments when only comparisons of cold waters were being made, and at intervals of three days when comparisons of both hot and cold water were being made. While with this period of contact larger amounts of the metals are taken into solution than would occur under ordinary household conditions, the results are directly comparative, and show more clearly the different corrosive properties of each water than would be the case if a shorter period of contact was given and less metal taken into solution.

RELATIVE CORROSION OF IRON PIPES BY MERRIMACK RIVER WATER BEFORE AND AFTER FILTRATION THROUGH SLOW SAND AND MECHANICAL FILTERS, AND BY A POND AND A DRIVEN-WELL SUPPLY.

In this experiment, river water and the effluents from slow sand Filter No. 8A and from mechanical Filter No. 336, operated with the use of aluminum sulphate, and water from a pond and from a driven-well supply, were allowed to remain in the pipes for periods of one week. A description of these filters and analyses of their effluents and of the river water have been given in preceding pages. In the town using the pond supply, more or less trouble has been experienced with rusty water, particularly in houses having iron hot-water supply pipes, while in the town using the driven-well supply there has been some complaint of the corrosion of boiler tubes.

The individual results varied considerably from one another; the absorption of iron by the mechanically filtered water was always very much greater than that by any of the other waters, and the amount of iron absorbed by the effluent from the slow sand filter was usually slightly greater than that absorbed by the river water. Both the pond water and the driven-well water were more corrosive than the river water or the effluent from the slow sand filter. The driven-well water showed a somewhat greater absorption of iron than the pond supply experimented with.

The average results obtained in this experiment are shown in the following table: —

Merrimack River Water.

Pipe Number.	Number of Samples.	Water used for filling Pipes.		Water after standing in Pipes One Week.	
		Alkalinity.	Iron.	Iron.	Times Iron increased.
7, ...	34	1.3	.107	2.40	22

Effluent from Slow Sand Filter No. 8A.

Pipe Number.	Number of Samples.	Alkalinity.	Iron.	Iron.	Times Iron increased.
6, ...	34	1.1	.048	2.85	59

Effluent from Mechanical Filter No. 336.

Pipe Number.	Number of Samples.	Alkalinity.	Iron.	Iron.	Times Iron increased.
8, ...	34	1.1	.024	4.40	183

Water from a Pond Supply.

Pipe Number.	Number of Samples.	Alkalinity.	Iron.	Iron.	Times Iron increased.
9, ...	14	1.0	.017	2.19	129

Water from a Driven-well Supply.

Pipe Number.	Number of Samples.	Alkalinity.	Iron.	Iron.	Times Iron increased.
10, ...	14	3.2	.020	2.94	147

"Number of samples" given above represents both the number of experiments and samples analyzed.

Effect of Amount and Kind of Alkalinity on Corrosion by Mechanically Filtered Waters.

In the previous experiments it has been shown that mechanically filtered water was more corrosive in these experiments than the same water before filtration or when purified by slow sand filtration. Experiments have also been made to determine to what extent the degree of alkalinity of mechanically filtered water governs its corrosive action, and if this corrosion can be lessened by increasing the alkalinity by the addition of soda ash or of lime. In these experiments, both Merrimack River water and the water from a certain lake supply, concerning the purification of which by mechanical filters an application had been made to the Board for advice, were studied. The raw waters were treated with sulphate of alumina in amounts sufficient to remove coloring matters (1.3 to 1.5 grains per gallon), and after standing until coagulation occurred (three to eighteen hours, at different times), were filtered rapidly through a sand filter. Soda ash or milk of lime was then added in amounts sufficient to produce the desired alkalinity, and the waters so prepared were placed in the pipes and allowed to remain for seven days. In general, the results of these experiments indicated that waters made alkaline with lime were slightly less corrosive than when the same amount of alkalinity was produced by the addition of soda ash, and that there was a slight decrease in the corrosive action of the lime-treated waters as its alkalinity or hardness was increased. This decrease was relatively small, however, unless its alkalinity was increased to such a point that the hardness would be noticeable to the consumer. An increase in alkalinity by the addition of soda ash apparently had little effect upon the corrosive action of the waters. As in the preceding experiments, the mechanically filtered waters were much more corrosive than were the corresponding waters before treatment, the only exception being those waters to which an excessive amount of lime was added after filtration. The results of these experiments are shown in the following tables: —

Merrimack River Water.

Alkali added.	Pipe Number.	Number of Samples.	WATER USED FOR FILLING PIPES.		WATER AFTER STANDING IN PIPES ONE WEEK.	
			Alkalinity.	Iron.	Iron.	Times Iron increased.
-	7	24	1.3	.107	2.40	22

Mechanically Filtered River Water.

None.	27	8	0.2	.013	4.56	350
Soda.	26	8	0.6	.019	5.33	281
Soda.	26	7	2.0	.020	5.30	265
Soda.	26	14	3.1	.012	5.10	425
Lime.	27	4	1.8	.029	4.12	142
Lime.	27	11	3.1	.019	3.20	168
Lime.	27	6	4.6	.014	2.75	197

Lake Water.

Alkali added.	Pipe Number.	Number of Samples.	Water used for filling Pipes.		Water after standing in Pipes One Week.	
			Alkalinity.	Iron.	Iron.	Times Iron increased.
-	9	17	1.4	.032	2.33	70

Mechanically Filtered Lake Water.

Soda.	10	13	0.7	.015	3.20	214
Lime.	10	3	1.8	.013	3.20	244

Relative Corrosion by Hot and Cold Water.

In many places where complaint has been made of "red water troubles," the most serious has occurred with water after passage through household hot-water tanks and plumbing fixtures. The water fronts used to heat the water are either of cast iron or of brass, the hot-water tanks may be of copper, galvanized iron or of galvanized steel, while the piping may be either of iron, steel, galvanized or ungalvanized, or of brass. The problem is frequently complicated by the use of these various metals in different parts of the hot-water plumbing, with the probability that a portion, at least, of the corrosion is due to galvanic action at the junction of unlike metals. Only the action of hot and cold waters on iron and galvanized-iron pipes used alone has been investigated up to the present time, the waters being allowed to remain in the pipes three days in each case. The mechanically filtered lake water used in this experiment was prepared as described in the preceding experiment, the alkalinity being due to added lime. With both the plain iron and galvanized-iron pipes, the absorption of iron was much greater when in contact with hot water than with cold water when using waters of about the same degree of alkalinity. The effect of varying the alkalinity is peculiar, however, an increase in the alkalinity causing an increase in the absorption of iron from both kinds of pipe when filled with cold water, and the reverse when filled with hot water. As noted in the preceding experiments, the absorption of iron was much greater by the mechanically filtered waters than by the untreated waters or by the effluent from the slow sand filters. The results show the value, for a time at least, of the protective coating on the galvanized pipes in the prevention of red water, in every case the amount of iron in the waters from the galvanized pipes being very much lower than in the same waters from the uncoated pipes. The sources of the iron in the samples from the galvanized pipes were undoubtedly the places where the iron was unprotected, owing to defective coating or by the cutting of threads in jointing the pipe. In the majority of cases the amount of iron in waters from these galvanized pipes, though small, appears to be gradually increasing, and tests for zinc indicate that the protective coating is being gradually eaten away as the pipes are continued in use.

The average absorption of iron by the various waters used in this experiment from both the plain iron and galvanized pipes are shown in the following table: —

Plain Iron Pipes.

	Number of Samples.	Water used for filling Pipes.		Iron in Water after standing in Pipes Three Days.		Times Iron increased.	
		Alkalinity.	Iron.	Cold.	Hot.	Cold.	Hot.
Merrimack River water,	15	1.5	.067	3.57	5.60	53	84
Effluent from slow sand Filter No. 8A,	15	1.4	.035	3.91	3.79	112	108
Effluent from mechanical Filter No. 336,	15	1.4	.007	4.92	5.99	725	855
Lake water,	6	1.2	.045	4.07	8.55	91	190
Mechanically filtered lake water,	6	1.3	.009	5.07	6.35	634	705
Mechanically filtered lake water,	6	2.3	.009	5.95	4.75	662	528
Mechanically filtered lake water,	6	3.9	.009	6.48	4.42	720	491
Galvanized-iron Pipes.							
Merrimack River water,	15	1.5	.067	0.14	0.76	2	11
Effluent from slow sand Filter No. 8A,	15	1.4	.035	0.06	0.31	2	9
Effluent from mechanical Filter No. 336,	15	1.4	.007	0.07	0.50	10	71
Lake water,	6	1.2	.045	0.16	0.74	4	16
Mechanically filtered lake water,	6	1.3	.009	0.06	0.73	7	81
Mechanically filtered lake water,	6	2.3	.009	0.07	0.44	8	49
Mechanically filtered lake water,	6	3.9	.009	0.13	0.34	14	38

EFFECT OF AMOUNT OF DISSOLVED OXYGEN.

In order to study the effect upon corrosion of the amount of dissolved oxygen in water, two sets of pipes, each consisting of a plain iron and a galvanized-iron pipe, have been operated with distilled water containing different amounts of oxygen, the water being allowed to remain in the pipes seven days in each case. The distilled water used in filling one set of pipes was thoroughly aërated, while that used in filling the other set was blown out with steam to remove dissolved air, and cooled before use. Considerable difficulty was experienced in preventing the absorption of oxygen in this water during the operations of cooling and filling the pipes. After numerous experiments the method of cooling the water and of filling the pipes under an atmosphere of illuminating gas was adopted as most successful. Usually the pipes could be completely filled in this manner with a water of low oxygen content, although it was seldom possible to have the water absolutely free from dissolved oxygen after placing it in the pipes. Determinations of the amount of dissolved oxygen in the water in each pipe were made immediately after filling, and after the seven-day period in each case.

The amount of oxygen in the water in each pipe fluctuated through considerable limits, but no regular relation was to be observed between the amount of oxygen in the water and the amount of iron dissolved by the water. The absorption of iron by the water originally of high oxygen content was much greater than that by the water of low oxygen content in both the plain iron and galvanized-iron pipes; and, as shown in preceding tables, the absorption of iron from the galvanized-iron pipes was very much less than from the plain iron pipes. The absorption of zinc from the galvanized pipes was practically the same with both waters, averaging about 2.46 parts per 100,000 for the water high in oxygen and 2.35 parts for the water low in oxygen. In all cases the amount of dissolved oxygen in the water was very much reduced after standing seven days in the pipes.

The average results of the first twenty-five fillings of these pipes are shown in the following table: —

Plain Iron Pipes.

PIPE NUMBER.	WATER USED FOR FILLING PIPES.		WATER AFTER STANDING IN PIPES ONE WEEK.		
	DISSOLVED OXYGEN.		DISSOLVED OXYGEN.		IRON.
	Parts per 100,000.	Per Cent. of Saturation.	Parts per 100,000.	Per Cent. of Saturation.	Parts per 100,000.
28, ...	.91	93	.08	8.6	1.80
29, ...	.17	19	.04	0.1	0.76

Galvanized-iron Pipes.

30, ...	.88	92	.07	7.6	0.15
31, ...	.13	15	.02	2.5	0.10

SUMMARY AND CONCLUSIONS OF EXPERIMENTS SO FAR MADE WITH IRON PIPES.

Water containing excessive amounts of dissolved and suspended iron, or "red water" as it has come to be called, has been more or less common at certain locations or at certain times in the operation of many municipal water-distribution systems. Usually such conditions have been of short duration, or have been more or less completely alleviated by repeated flushing of the pipes, except in a few cases where the "red water" trouble has become so serious and so persistent that it has occasioned more than local interest, and more or less complete investigations have been made of local conditions. The broad question as to why certain waters are more corrosive in their action upon iron pipes than others, and as to why the same water is apparently more corrosive in one place than in another, is of considerable importance, and the results presented here are a part of an investigation to obtain data in regard to this matter. The investigation is not yet finished, but it is evident that those so far made have given results that are in accord with observations in various parts of the country; namely, that when soft waters are purified by coagulants and mechanical filters, they have a greater corrosive action upon iron than before such purification, and greater than the same supply when filtered through sand, and that increasing the hardness of the mechanically filtered water to a reasonable degree has little effect upon preventing corrosion.

The results illustrate the great variation in the absorption of iron by waters of different kinds, and show that usually such waters are much more corrosive in their action when heated than when cold. The Merrimack River water was much less corrosive than the waters from the ground supply and from the other two surface water supplies tested, each of which contained very much smaller amounts of organic matter than did the river water. The purification of the Merrimack River water by slow sand filtration caused a slight but appreciable increase in the corrosive action of that water. The purification of the Merrimack River water by the use of chemicals and mechanical filtration, by which a large proportion of the organic matters in the water were removed, caused a marked increase in the corrosive properties of the water, and a similar increase in corrosive action was noted in the case of the lake water after mechanical filtration. On the other hand, the distilled water, from which all organic matters had been removed, absorbed far less iron than any of the other waters tested. In the case of the distilled water, however, not only organic matters but mineral matters as well had been completely eliminated, the absence of which undoubtedly introduced another factor into the problem. The experiments with the distilled waters illustrate the part the amount of oxygen may play in the absorption of iron, the water of low oxygen content being much less corrosive than that containing large amounts of oxygen. These results are in accordance with those obtained elsewhere in studies of the factors influencing the corrosion of structural iron and steel, in which it has been proved that the presence of oxygen is an important factor.

The comparative results obtained with plain iron and galvanized-iron pipes illustrate the value of the protective coating of zinc in the latter. In every case the amount of iron absorbed from the galvanized pipes was extremely small when compared with the amount absorbed from iron pipes by the same waters. The comparatively large amounts of zinc found in the water from the galvanized pipes, however, show that the galvanizing is being gradually eaten away, and indicate that the amount of iron absorbed is gradually increasing.

REVIEW OF LITERATURE ON CORROSION.

The results of the action of water upon metals may be considered from the following viewpoints: —

1. From the effect of dissolved or suspended metals upon public health. From this viewpoint the action of water upon lead is most important, since that metal, owing to its accumulation in the human system, is most toxic. There is little evidence that other metals commonly used in pipes and household fixtures are toxic in the amounts in which they are usually present, although there are one or two cases recorded in which excessive quantities of zinc have been reported to have caused more or less trouble.

2. From the dissolved or suspended metals rendering the water unpleasant to the sight or taste, or unsuitable for laundry or other purposes. Troubles of this nature are usually due to iron, and it is probable that zinc, copper, tin or lead, in the amounts in which they are likely to occur in water, would never be noticed by the consumer.

3. From the viewpoint that the strength or length of life of water mains or household fixtures may be reduced, or that the metal absorbed in one place may be redeposited at other places in the distribution system, causing a reduction in the carrying capacity of the pipes.

The literature on corrosion from all these viewpoints is more or less closely correlated, in many instances results of investigations upon one phase of the problem being equally applicable to another phase. In the following pages it has been attempted to present the various aspects of corrosion as revealed in the literature on the subject, with particular reference to the facts and theories which apply to the first two phases of the problem and to the investigations upon which a preliminary report has been made in the foregoing pages.

Corrosion and the Public Health.

The literature on corrosion from this viewpoint dates back almost to the beginning of the use of metal pipes or cisterns to convey or store water. Hippocrates, more than four hundred years before the Christian era, recognized and commented upon the danger of lead poisoning from the use of mountain spring waters conveyed in lead pipes, or from rain water stored in lead cisterns. The fact that water sometimes became poisonous after being conveyed through lead pipes was also recognized during the middle ages. About the middle of the nineteenth century, with the increased distribution of water by pipes of various kinds, the fact that lead poisoning was common in certain localities, while it was not found in others, became noticeable, and the fact that different waters varied in their action upon lead came to be recognized. In 1875 Muir (1) published the results of his studies, showing the relation of dissolved substances upon the amount of lead absorbed by water, and these were followed by more extended studies along the same line, published two years later. Since that time a number of similar investigations have been reported. In 1888 Muller (2) stated that the action of soft waters upon lead was a function of dissolved oxygen and carbonic acid; that in the absence of either one there was little lead dissolved, but that in the presence of oxygen the amount of lead taken into solution increased with the amount of CO_2 up to a certain point, but that above that point an increase in the amount of CO_2 caused a diminution in the solvent action of the water. The action upon lead of the peaty waters of certain districts of England has been studied extensively, and in a number of places such waters have been treated with soda or lime to neutralize the CO_2 and diminish the solvent power. In 1898 (3) and 1900 (4) results of the action of Massachusetts waters upon various metals were given in the reports of the State Board of Health for those years. The investigations in regard to the action of water of different kinds upon lead service pipes were summarized by Clark in the report for 1900 as follows: —

> The results of the investigation up to the time of writing the report in 1898 seemed to show that the cause of the taking of lead from the service pipes by the water of certain towns and cities was the presence of a considerable volume of free carbonic acid in the ground waters, and further investigation has con-

firmed this conclusion. Many laboratory experiments during the past three years have shown that while pure soft water, especially when containing some dissolved oxygen, attacks lead, and while the presence of coloring matter, free ammonia, nitrates and nitrites in soft water also causes considerable solvent action upon lead in laboratory experiments, yet, taking into consideration the results of our entire investigation, we find that in actual practice, with the conditions prevailing in the service pipes of a distribution system, a potable water in Massachusetts to have any dangerous lead-dissolving action must contain considerable free carbonic acid. It is not sufficient that a water be simply soft or comparatively free from mineral matters in solution alone to enable it to take a dangerous amount of lead from service pipes in actual use. This is shown by results of analyses of samples of water collected from lead service pipes in towns supplied with surface water, most of these surface waters being softer than the average ground water of the State, but nevertheless not attacking lead to any great extent. Neither is the presence of an abundance of oxygen in the water in a distribution system, except when free carbonic acid is also present, any considerable factor in dissolving lead from service pipes in actual use, as is shown by the analyses of the samples from surface-water supplies, although in laboratory experiments the opposite sometimes seems to be the case. There are some indications that the composition of the mineral contents of a ground water may influence slightly its action upon lead, and also that any considerable quantity of oxide of iron, separating from the water and depositing in the service pipes, has sometimes an appreciable action upon the lead. These are minor influences, however. It was shown also in the first report that the greater the hardness of the water as compared with its free carbonic acid, the less effect did this carbonic acid have upon lead, and further investigation has confirmed this.

The literature upon the absorption of zinc, tin and copper by water as affecting the public health is not extensive, as these latter metals are generally believed to have little or no toxic effect in the amounts in which they are found in waters as supplied to consumers. The action of Massachusetts waters upon zinc-lined, iron, tin and copper pipes was investigated and discussed by Clark, however, in the article just quoted. In the case of zinc it should be noted that Weinland (5) found zinc up to 0.5 part per 100,000 absorbed by water from galvanized-iron pipes at the University of Tubingen, and in slightly lesser amounts at a number of places in the town, and believed such large amounts might be harmful in a degree. Furthermore, Schwarz (6) describes a case where a well water drawn through a galvanized-iron pipe contained 3.2 parts per 100,000 zinc, and states that the persons using the water complained of frequent intestinal disturbances. Mason (7) states that zinc up to 2.3 parts per 100,000 in drinking water is not harmful.

Corrosion and Red Water.

While the fact that metals absorbed from pipes or other containers might render the water unpalatable or unfit for use in laundries has been well known for many years, it is only during the past few years that the subject of corrosion has come into prominence, owing to the extreme discoloration of the water as drawn from household fixtures in certain places, either following a change in the character of the water supply, or following a change or renewal in the plumbing fixtures, and sometimes for no apparent reason at all. The fact that the iron-bearing waters would precipitate out, or that growths of Crenothrix or similar ferruginous algæ in pipes carrying such waters would result in much complaint about rusty water, has been well known for many years. As far back as 1878 a severe epidemic of rusty water in Berlin was traced to growths of Crenothrix, and in 1887, during a similar epidemic, an exhaustive study of this and similar organisms was made by Hugo de Vries (8). Studies of the presence of Crenothrix in Massachusetts water supplies were made in the years 1887 to 1890, and the occurrence of this organism in water supplies and its liability to render such waters unfit for use were discussed at some length in the report of the Massachusetts State Board of Health for 1890 (9). In 1909, in an article in the "Engineering Record" (10) under the heading "The Red Water Plague," attention was called to the occurrence of rusty or "red water" in a number of places, and it was stated that such troubles were more common and more serious in the case of some ground waters and certain soft waters of the east and south which had been purified by mechanical filtration, the untreated surface waters of the east giving little trouble, and the same being true of the hard western waters, even after mechanical filtration. Ledoux (11) shortly afterward called attention to the fact that the swampy waters at Charleston, S. C., were extremely corrosive, but that after mechanical filtration their corrosive power was greatly reduced, although if sufficient coagulant (sulphate of alumina) was used to entirely remove the coloring matters, the water was rendered more corrosive than was originally the case.

In a general article upon the corrosive action of water upon metals before the New England Water Works Association in 1910, Weston (12) mentions the fact that the natural acid waters from Dismal Swamp, Va., are also extremely corrosive. He also notes that at Exeter, N. H., there has been more or less complaint of red water in hot-water systems since the introduction of mechanically filtered water, although this water has at all times been alkaline and free from all traces of sulphate of alumina, and states that in the latter case the corrosion was undoubtedly due to change in the character of the water, owing to the removal of organic matters. In this connection the writers might state that they have recently had an opportunity to inspect some gates and fire hydrants which had been in use for many years at Exeter, and that the hard scale of organic matter with which the insides of the pipes had been coated by the water previous to filtration had been quite largely disintegrated; and, furthermore, considerable corrosion was observed at the junction of brass and iron in the hydrants, which corrosion it was stated had never been noticed on similar gates previous to the change in the water supply.

The fact that waters purified by the use of sulphate of alumina might be more corrosive in their action upon metals was first mentioned by Fuller in the reports of experiments upon the purification of the Ohio River water at Louisville (13) and at Cincinnati (14) in 1899, and at that time suggestion was made that the corrosive action might be checked in part by the use of lime. In a recent review of the action of water on metal pipes, Fuller (15) again calls attention to this suggestion, and also states that the effluents from slow sand filters may be more corrosive than the unfiltered water.

The most extensive investigation of red water troubles yet published was that made by Whipple (16) at Springfield early in 1910. In this investigation the greater part of the trouble was found to be in places where the plumbing had been recently installed, and where a poor quality of galvanized steel was in use for pipes and hot-water boilers. The cause of the trouble in this case was attributed to galvanic action either in the imperfectly galvanized materials or at the junction of unlike metals, and filtered water which had been recently introduced was believed to have had no part in the corrosion, since in many cases the red water troubles antedated the change in the character of the water.

In a recent communication Woolson (17) notes that in the municipal bathhouses of New York City the hot-water pipes have to be replaced frequently, and that there is apparently little difference in the rate of corrosion of galvanized-iron and galvanized-steel pipes.

Theories of Corrosion.

The larger part of experimental work and investigation upon the subject of corrosion has been made from the viewpoint of the weakening or destruction of appliances made of metals rather than to that of the absorption of metals into water; but much of this work, particularly that of the theoretical chemists upon the causes of corrosion, is equally applicable to the present problem. The subject of the corrosion of iron and steel has received by far the most attention, owing to the wide uses of those metals, and much of this bears more or less directly upon the "red water" problem. There are three well-defined theories of the causes of the corrosion of iron: the carbonic acid or acid theory, the electrolytic theory and the hydrogen peroxide theory. The three theories overlap in many particulars, and the influence of many of the various factors in corrosion are explainable by either of the theories. Practically all investigators agree on the fundamental facts that iron cannot rust without the presence of water, and that the presence of oxygen is necessary. The carbonic acid theory apparently originated in the studies of Grace-Calvert (18) in 1871, but received little attention until about 1888, when it was advanced by Brown (19). According to the theory, the iron is first dissolved by an acid, even the very weak acids, such as carbonic acid, being sufficient. The ferrous salt is then oxidized by the oxygen present, the ferric hydroxide formed being precipitated and the acid liberated to act on more iron. The process is thus considered as a cycle, in which a small amount of acid can effect the solution of a considerable amount of the metal. The electrolytic theory apparently originated in a paper published by Whitney (20) in 1903, and is based on the fundamental principles of theoretical chemistry, that water and all substances in dilute solution are more or less completely dissociated into ions which convey positive and negative charges of electricity, the corrosion being caused by one or more of the ions in solution being replaced by the metal. According to this theory the hydrogen ions are most easily replaced, and hence become the active factor in the corrosion. Anything in solution, or any external force which will increase the concentration or relative number of hydrogen or similar ions, will increase the corrosive power of the water, while anything which tends to diminish the concentration of the hydrogen ions will lead to a decrease in corrosion. According to this theory the metallic iron is attacked by the hydrogen ions, Fe going into solution as ferrous iron and hydrogen changing from the ionic to the molecular or gaseous form. The ferrous iron in solution is oxidized, if oxygen be present, to the ferric state, and precipitates out. If this theory is correct, iron should be attacked by the hydrogen ions in the purest water, even in the absence of oxygen, and this was disclaimed by a number of chemists, — among them Dunstan (21), who in 1906 advanced the hydrogen peroxide theory as better explaining the corrosion of iron. This theory, which is based upon the older theory of oxidation in general, as worked out by Traube (22) in 1881, assumes that when oxygen and water are brought into contact with iron, ferrous oxide and hydrogen peroxide are formed, which immediately react with one another to form ferric oxide and water, while any excess of hydrogen peroxide formed by the first reaction attacks the iron directly. This theory would derive some confirmation from the results obtained by Shearer (23) and others, who have shown that H_2O_2 is formed when certain metals — aluminum, zinc and magnesium — are placed in water containing dissolved oxygen. Painstaking experiments, however, have never been able to demonstrate even the transitory presence of H_2O_2 from the contact of iron and water, while Moody (24) and Cushman (25) have both shown that pure hydrogen has no action upon iron. In the case of the corrosion of pure iron, therefore, this theory is apparently untenable. The electrolytic theory, although combated by Moody (24), Dunstan (21), Friend (26), Reed (27) and other advocates of the other theories, has been recently established by the researches of Walker (28) and of Cushman (25), and is now quite generally accepted as the most reasonable explanation of the corrosion not only of iron, but also of other metals. The well-known laws of the solution and deposition of metals by electric currents enter into the broader aspects of corrosion according to this theory, and explain many phases of the corrosion problem which the other theories cannot explain in an entirely satisfactory manner. The electrolytic corrosion of metals by stray electric currents is well known. Bergius and Krassa (29) have recently shown, however, that corrosion of this kind is almost always caused by direct currents, and that alternating currents have comparatively little corrosive action. While corrosion due to stray currents has assumed considerable importance as affecting the strength and life of water mains and other metal structures, such corrosion in the case of water pipes is usually, if not always, external, and does not lead to increased amounts of iron or other metals in the water within the pipes.

The small currents of electricity generated between metals of different potential, however, are important factors in the corrosion problem. Theoretical and electrical chemists have found by painstaking experiments that the metallic elements vary widely among themselves in electrical potential. A partial list of the elements, arranged in series according to those differences in potential, is as follows: potassium, sodium, calcium, magnesium, aluminum, manganese, zinc, iron, cobalt, nickel, tin, lead, hydrogen, copper, silver, platinum. As stated by Thompson (30) almost thirty years ago: "The order in which these metals are arranged is in fact nothing else than the order of oxidizability of the metals. . . . It also shows the order in which the metals stand in their power to replace one another. . . . In this order, too, the lowest on the list first, are the metals deposited by an electric current from solutions containing two or more of them; for that metal comes down first which requires the least expenditure of energy to separate it from the elements with which it was combined."

In 1894 and 1895 Wood (31) called attention to the fact that electric currents caused by unequal heating of different parts of a steam boiler were responsible, at least in part, for the destruction of boiler tubes. The fact that impurities in the metal cause local electrolytic action has been discussed by Burgess (32), and Howe and Stoughton (33), while Cushman (34) has shown that even the purest iron is thrown into nodes of positive and negative potential when immersed in water, and that a scratch on the surface of a polished plate may be of different potential from the remainder of the surface, and become the starting point for corrosive action. It has further been shown that strains or stresses produced in cooling the metal during manufacture may result in differences of potential. It is also well known to theoretical chemists that many reactions are reversible, and that in dilute solutions of two metals it is quite possible to have such a condition of equilibrium that the addition of either one will precipitate the other. For example, under ordinary conditions, if a strip of zinc be immersed in a solution of copper, the zinc will go into solution and the copper will be precipitated, according to the laws as laid down in the table of relative potential given above. Smith (35) has shown, however, that if the concentration of copper ions be sufficiently low, and the concentration of zinc ions be sufficiently high in the same solution, the reaction is reversed, and a strip of copper immersed in the solution will precipitate the zinc ions and copper will be dissolved. These reversible reactions have been comparatively little studied, but it is probable that in the small amounts in which the metals are commonly present in water such reactions may be more common than are at present suspected. In this case it is simply a case of a difference or change of potential. A similar case is that demonstrated by Schleicher (36) in the rusting of iron, in which the metal absorbed in one place is precipitated as oxide at another; but that after a time there may come a change in potential due to the accumulation of rust, and that rust may begin to form at the point from which the metal had previously been dissolved, while the iron was eaten away around or under the rust first formed. This in a measure explains the scaling off of the iron rust formed in water pipes, and accounts in part for the appearance of red water at certain times and not at others.

Factors in Corrosion.

Various other factors enter into the corrosion and red-water problem. Traube and Mengarini (37) have shown that many of the metals go into colloidal solution in the absence of oxygen, and may be precipitated, or go into true solution, when they later come in contact with oxygen. Even some of the oxides may go into colloidal solution. So far as the authors know, the electrolytic theory has not been applied to colloidal solutions. In general, however, most of these factors are of such nature as to facilitate corrosion by making the water a better electrolyte, or by setting up auto-electrolysis. Gaines (38) and Kuichling (39) each call attention to the influences of certain salts, particularly Cl and SO_3, in ground waters as assisting corrosion. The effect of various amounts of substances present in natural waters upon lead was studied by Clark and Forbes (4), and it was found that nitrates and ammonia accelerated, and certain mineral matters and organic matters retarded, corrosion. Heyn and Bauer (40) found that the corrosion of iron in water was greatly influenced by the kind and amount of salts in solution, and that mixtures of different salts reacted quite differently from simple solutions. For example, they found that NaCl and NH_4Cl increase the corrosion, while KNO_3 and Na_2SO_4 had little apparent effect, and Na_2CO_3 retarded it; but that a mixture of KNO_3 and Na_2CO_3 was quite corrosive, and in general the protective action of $K_2Cr_2O_7$ and other similar salts was reduced or reversed by the presence of NaCl.

Moody (41), Huntley (42) and others have shown that the sulphur in steel may become oxidized to SO_2, rendering the water acid, thus increasing the corrosion. Howe and Morrison (43) have shown that certain hard waters containing an excess of CO_2 and magnesium were extremely corrosive for brass, zinc and lead, but did not attack aluminum or nickel, and acted only slightly on iron in the absence of an excess of air. Jones (44) studied the action of acid mine waters on brass and bronze, and found that the resistance to corrosion varied through wide limits with different alloys: Lincoln and Bartells (45) found that the corrosion of brass in sea water increased with the amount of copper in the alloy. Rhead (46) states that the corrosion of brass is due in many instances to the imperfect mingling of metals in the alloy, causing auto-electrolysis between unlike metals. Phelps (47) found that the St. Louis water, after coagulation with iron and lime, is rendered extremely corrosive to galvanized-iron pipes, and states that this is due to increased electrolytic action, caused by the removal of CO_2 ions and the substitution of SO_3 ions. The action of St. Louis water upon metals and alloys was exhaustively studied by Montfort (48) in 1909, because of the rapid corrosion of parts of water meters. In this investigation it was found that the water corroded zinc and aluminum rapidly, and that alloys containing considerable percentages of those metals could not be satisfactorily used in fixtures in contact with that water. The effect of iron and lime treatment is stated by Montfort to increase the neutral carbonates in solution, which result in a twofold effect on metals; first, a protective effect by the precipitation of carbonates upon the inside of the water mains; second, an inhibition of corrosion by the increased number of hydroxyl ions in the water. This latter effect, however, while acting to protect the iron water mains, is entirely overcome whenever there is a bimetallic contact by the increased electrolytic effect of the dissolved saline matters. The increase in the corrosive properties of waters which have been treated with sulphate of alumina has already been noted. The chemical reactions involved result in a considerable increase in the amount of the carbonic acid dissolved in the water, and more or less of the organic matter which inhibits corrosion to a greater or less degree is removed by sedimentation and filtration, which usually follow such treatment. The increase in the corrosive power of naturally filtered waters is due to much the same reasons, the CO_2 in this case being the result of bacterial action within the filters. That naturally filtered waters are less corrosive than mechanically filtered waters is stated by Fuller (15) and by Weston (12) to be due to the facts that the carbonic acid content is generally less, and that a lesser amount of the protective organic matter is usually removed by slow sand filters.

Sherrard (49), Weston (12), Ledoux (11) and many others have called attention to the fact that many swamp waters are acid and are exceedingly corrosive. Fuller (15) states that the active agents in swampy waters are the humic acids, and this view is accepted by some investigators. Endell (50), however, refutes this statement, and shows a long series of experiments to prove the older idea that the excessive corrosion was due to carbonic acid. That the source of carbonic acid in such waters is the result of bacterial decomposition is generally accepted. Gaines (51), however, has recently called attention to the fact that certain species of bacteria attack the iron directly, or by the production of other acids, such as SO_2. In one instance, which he quotes, tubercles of iron rust were found to be practically a solid culture of iron-dissolving bacteria. The fact that certain algæ such as Crenothrix grow best in iron-bearing waters, and the fact that such growths may cause more or less serious red-water troubles, has already been stated. The fact that red-water trouble is more frequently noted in case of the hot-water services, and that boiler tubes and pipes carrying hot water corrode more rapidly than do pipes carrying cold water, has already been noted. It is well known that practically all substances are dissolved more rapidly, and that most chemical reactions proceed more rapidly, as the temperature of the solvent increases. Furthermore, it has previously been stated that anything which tends to increase the concentration of the hydrogen ions in solution leads to an increase in corrosion, but that molecular or gaseous hydrogen which is liberated by electrolysis, by collecting on or about the place where it is formed, tends to retard electrolytic action. The solubility of all gases in water and the adhesion of small bubbles of gas to the surface of metals are greatly diminished in hot water, however, and with the escape of the inhibiting molecular hydrogen, conditions for further electrolysis are improved. The liberation of considerable quantities of gaseous hydrogen from hot water in iron pipes was demonstrated by G. O. Adams (52) in 1900. In ordinary hot-water services the hydrogen escapes as the water is drawn, and the hydrogen formed by the corrosion in steam boilers passes off with the steam. In closed hot-water or steam heating systems, however, this hydrogen cannot escape. The fact that the gas collecting in the tops of radiators in closed heating systems is readily inflammable may be proved by any one. Adams analyzed many samples of such gas, and found that a large proportion of hydrogen, varying from 44 to 78 per cent., was always present, while oxygen was usually absent.

Prevention of Corrosion.

The prevention of corrosion has been attempted in a number of ways: (1) By the use of protective coatings, which keep the water away from the metal. (2) By reducing the amount of galvanic action by changing the difference in potential between different metals in the same system or between different parts of the same metal at different parts of the system. (3) By changes in the character of the water as an electrolyte.

The use of paint and varnish coatings to prevent the access of water to the metal is well known, and iron and steel pipes for water mains are usually coated both inside and out with some preparation by the manufacturer. The value of such coatings is dependent upon perfect adhesion to the metal, and by the production of a uniformly impervious film. Coatings of this nature are seldom free from pin-holes, and frequently become broken or scratched in handling the pipes in transportation or in laying. The relative value of different materials for such coatings has received much study by engineers and water works officials, and has been discussed by Sabin (53), Toch (54), Harper (55), Wood (31), Cushman (56) and others. Of special interest are the long-term experiments with different coating materials upon large water mains at Rochester, N. Y., recently described by Gaines (38) and by Kuichling (39). The cause of failure of such coatings and the extensive corrosion which may occur in metals under such coatings have been recently shown by Walker and Lewis (57) to be due to the use of unsaturated oils in the preparation, which upon oxidation act as depolarizing agents, liberating the hydrogen ions and thus accelerating the corrosion. The use of cement concrete for lining pipes and to protect the outside of pipes and structural steel is well known. Cushman (56) states that the protective agent in this case is the free lime formed during the setting of the concrete, and that when this lime is leeched out rusting will take place. In the same class of preventive measures may be included the use of a layer of some less readily oxidized metal, as in the case of the common use of nickel-plated plumbing fixtures and galvanized or zinc coated pipes and of lead-lined pipes. Metal coatings of this nature are often very effective, but in the case of small water pipes the coating is seldom perfect, or is broken by the process of cutting and joining such pipes. Under such conditions local galvanic action is set up and the corrosion may be much accelerated. As shown in discussion of the electrolytic theory and the potential series of metals, in galvanized-iron pipes under such conditions the zinc would go into solution and the iron would be protected until the surface was uncovered in places sufficiently large for the corrosion of the iron to go on independently and simultaneously. In the case of tin, the reverse would be true, the iron going into solution. The rapid corrosion of tin plate or tin-coated sheet iron when once started is a matter of common observation. These facts have been discussed by Cushman (25), Howe (58), Walker (28), Weston (12), Fuller (15) and others, and are reasonably well understood.

Many different methods for reducing corrosion by eliminating galvanic action, or by causing that action to take place in such a manner that the corrosion should be upon some easily replaced part, have been suggested or attempted. Burgess (32) suggests that if an iron bar placed within a steam boiler be kept charged with slight currents of electricity, all the corrosion would be upon this bar, and the life of the boiler proper would be greatly increased. The use of zinc strips in steam boilers for the same purpose is well known and has been practiced for many years (25). Sherman (59) found by experiment that steel or bronze in sea-water could be protected from corrosion by wrapping with strips of zinc, and Corner (60) states that the corrosion of copper and brass on shipboard is frequently prevented by the free use of iron in contact with these metals, the iron in this case being the more readily corroded and cheaper metal, which can be replaced when necessary. The use of zinc plates to protect structural steel from electrolysis when buried in the ground is well known to engineers (61). The reduction of auto-electrolysis in iron and steel by the use of metal containing less impurities and of more uniform structure and composition has been discussed by Cushman (25), Sang (62), Huntley (42), Speller (63), Howe (64), Howe and Stoughton (33) and others. The fact that iron or steel when surface treated with bichromate of potash, or lead chromate, is less subject to corrosion was discussed by Wood (31) in 1894, but the fact that this increased resistance is due to a polarizing action preventing electrolysis was apparently first brought out by Dunstan (21) and has since been confirmed by Cushman (25) and by Walker (28). The formation of a coating of magnetic oxide upon the surface of iron or steel has been stated by Weigelin (65) and by Sang (66) to exert a similar protective action, while a number of patent processes for protecting iron and steel by coatings of other iron salts have been exploited. Unfortunately, practically all of these methods lose their effectiveness after the metal has been submerged in water for a time.

The third class of protection or remedial measures is that dealing with changes in the character of the water as an electrolyte. As stated previously in discussion of the electrolytic theory, anything which will reduce the concentration of hydrogen ions in solution, or, conversely, anything which will increase the concentration of hydroxyl or similar ions, will tend to lessen or prevent corrosion. This was originally stated by Whitney (20) in 1903. The fact that iron will not rust when buried in dry lime has been known and taken advantage of for many years. The effect of increasing the hydroxyl ions in solution by the addition of certain salts was studied by Adams (52) in 1900. In these studies he found that Na_2CO_3, equivalent to about 56 grains per gallon, NH_3, equivalent to about 43 grains per gallon, or Na_2O, equivalent to about 5 grains per gallon, were required to entirely prevent the rusting of iron in pure water. The theoretical aspects of the treatment of public water supplies for the reduction of corrosion were discussed at some length by Freeland Howe (58) in 1908. The use of lime for reducing the action of peat waters on lead has been discussed by Mason (7), while the reduction in corrosive properties of mechanically filtered waters has been suggested and commented upon by Fuller (15), Weston (12) and others. The fact that the addition of soda ash in small amounts had comparatively little effect upon corrosion, and that lime in amounts which would render the water objectionable on account of its hardness would be required to appreciably lessen corrosion, was shown in the experiments discussed in the first section of this paper (see page 290). The failure of such treatment is explained, at least in part, by the results obtained by Adams in the experiments quoted above. Furthermore, Cribb (67) has shown that the use of an insufficient amount of alkali may accelerate rather than diminish the corrosion, especially in the case of steam boilers. Allied with this class of remedies is that proposed to prevent the corrosion in a long steel main of the Coolgardie, Australia, Water Works (68). After a careful investigation of the character of the water as an electrolyte, it was decided that the cheapest and most effective means of checking corrosion would be to entirely remove all dissolved oxygen from the water, and a de-oxidizing plant is now in process of construction.

The complete study of the character of the different waters themselves, the determination of the amount and nature of the dissolved substances present in those waters, and of the effect of those substances upon the character of the water as an electrolyte, appear to be a most fertile field for research, and one which may ultimately lead to methods of treatment by which corrosion inside the water pipes and such troubles as lead poisoning or red water may be effectively prevented.

REFERENCES.

1. Muir. Proc. Man. Phil. Soc., 1875, 31. Quoted by Roscoe and Schorlemmer, Treatise on Chemistry, 1900, Vol. 2, p. 722.
2. Muller. Jour. Chem. Soc., 54, 1888, p. 25. Quoted by Mason, Water Supply, 1896, p. 447.
3. Clark. Thirtieth Annual Report, Mass. State Board of Health, 1898, p. 541.
4. Clark and Forbes. Thirty-second Annual Report, Mass. State Board of Health, 1900, p. 487.
5. Weinland. Zeit. Nahr. Genussm., 19, 1909, p. 362.
6. Schwarz. Zeit. Nahr. Genussm., 14, 1907, p. 7.
7. Mason. Proc. Am. Phil. Soc., 46, 1907, p. 110.
8. Hugo DeVries. Die Pflanzen und Thiere in den dunkeln Raumen der Rotterdamer Wasserleitung, Jena, 1890.
9. Special Report on Water Supply and Sewerage, Mass. State Board of Health, 1890, p. 780.
10. Eng. Record, 60, 1909, p. 534.
11. Ledoux. Eng. Rec., 60, 1909, p. 701.
12. Weston. Jour. New Eng. Water Works Assn., 24, 1910, p. 559.
13. Fuller. Purification of Ohio River Water at Louisville, Ky., 1899.
14. Fuller. Purification of Ohio River Water at Cincinnati, O., 1899.
15. Fuller. Eng. Rec., 61, 1910, p. 550.
16. Whipple. Report to Springfield, Mass., Water Commissioners, July, 1910. Eng. Rec., 62, 1910, p. 118.
17. Woolson. Eng. News, 64, 1910, p. 630.

18. Calvert. Manchester Lit. Phil. Mem., 5, 1871, p. 104.
19. Brown. Jour. Iron and Steel Inst., 1888, p. 129.
20. Whitney. Jour. Am. Chem. Soc., 25, 1903, p. 397.
21. Dunstan. Jour. Chem. Soc. (London), 87, 1905 (2), p. 1548.
22. Traube. Ber. d. Chem. Ges., 18, 1881.
23. Shearer. Trans. Roy. Soc. Can. (3), 2, III., 1909, p. 171.
24. Moody. Proc. Chem. Soc. (London), 22, 1906, p. 101.
25. Cushman. U. S. Dept. Agr. Office of Public Roads, Bull. No. 30, 1907; Bull. No. 35, 1909. Also Cushman and Gardner, Corrosion and Preservation of Iron and Steel, N. Y., 1910.
26. Friend. Paper read Iron and Steel Inst., Sept., 1909, Engineering, 88, 1909, p. 531.
27. Reed. Trans. Am. Electrochem. Soc., 1903.
28. Walker. Jour. Am. Chem. Soc., 29, 1907, p. 1251. Also paper read Iron and Steel Inst., May, 1909. Trans. Am. Electrochem. Soc., 14, 1909, p. 175. Electrochem. Met. Ind. 6, 1909, p. 492. Engineering, 87, 1909, p. 708.
29. Bergius and Krassa. Zeit. Electrochem. 15, 1909, p. 418.
30. Thompson. Elements of Electricity, New York, 1893, p. 400.
31. Wood. Trans. Am. Soc. Mech. Eng., 15, 1894, p. 998. *Ibid,* 16, 1895, pp. 350 and 663. Also Wood, Rustless Coatings, New York, 1904.
32. Burgess. Jour. West. Soc. Eng., 14, 1909, p. 375.
33. Howe and Stoughton. Iron Age, 82, 1908, p. 645.
34. Cushman. Paper read Am. Soc. Testing Materials, Eng. News, 60, 1908, p. 23. Chem. Eng., 7, 1908, p. 2923.
35. Smith. Am. Chem. Jour., 37, 1905, p. 506. Jour. Am. Chem. Soc., 27, 1905, p. 540.
36. Schleicher. Metalurgie, 6, 1910, p. 182.
37. Traube and Mengarini. Zeit. Chem. Ind. Colloide, 6, 1910, pp. 65 and 240.
38. Gaines. Eng. News, 59, 1908, p. 578.
39. Kuichling. Jour. New Eng. Water Works Assn., 24, 1910, p. 514.
40. Heyn and Bauer. Mitt. Kgl. Prufungsamte, 28, 1910, p. 62.
41. Moody. Proc. Chem. Soc. (London), 25, 1909, p. 34.
42. Huntley. Jour. Soc. Chem. Ind., 28, 1909, p. 339.
43. Howe and Morrison. Jour. Am. Chem. Soc., 21, 1899, p. 422.
44. Jones. Metal Ind., Sept., 1905.
45. Lincoln & Bartells. Jour. Phys. Chem., 11, 1907, p. 501. *Ibid.,* 12, 1908, p. 550.
46. Rhead. Engineering, 88, 1909, p. 741.
47. Phelps. 1909 Report Master Plumbers Assn., Abst. Eng. News, 62, 1909, p. 518.
48. Montfort. Proc. Am. Water Works Assn., 1910, Abst. Eng. News, 63, 1910, p. 560.
49. Sherrard. Eng. Record. 62, 1910, p. 412.
50. Endell. Jour. Prak. Chem., 82, 1910, p. 414.

51. Gaines. Jour. Ind. Eng. Chem., 2, 1910, p. 128.
52. Adams. Thesis, M. I. T., 1900. Quoted by Whitney, *loc. cit.*, No. 20.
53. Sabin. Eng. News, 59, 1908, p. 673.
54. Toch. Trans. Am. Electrochem. Soc., 14, 1908, p. 207; 15, 1909, p. 391.
55. Harper. Eng. Digest, 6, 1909, p. 150.
56. Cushman. Paper read Iron and Steel Inst., May, 1909, Engineering, 87, 1909, p. 710.
57. Walker and Lewis. Jour. Ind. Eng. Chem. 1, 1909, p. 754.
58. Freeland Howe. Jour. N. E. Water Works Assn., 22, 1908, p. 43.
59. Sherman. Eng. News, 61, 1909, p. 292.
60. Corner. Engineering, 91, 1911, p. 95.
61. Hering. Discussion in Trans. Am. Electrochem. Soc., 3, 1903.
62. Sang. Proc. Eng. Soc. W. Pa., 24, 1909, p. 493. Also Sang, Corrosion of Iron and Steel, New York, 1909.
63. Speller. Iron Age, March 2, 1905.
64. H. M. Howe. Iron Age, June 28, 1906.
65. Weigelin. Stahl & Eisen., 28, 1910, p. 957.
66. Sang. Electrochem. Met. Ind., 7, 1909, p. 351.
67. Cribb. Analyst, 30, 1905, p. 225.
68. Eng. Record, 61, 1910, p. 671.

FOOD AND DRUG INSPECTION.

FOOD AND DRUG INSPECTION.

The report of the chief analyst presents in detail the work of this department for the year ended Nov. 30, 1910. The following personnel comprised the laboratory force: —

Hermann C. Lythgoe,	*Chief Analyst.*	Horace F. Davis,	*Inspector.*
Charles H. Hickey,	*First Asst. Analyst.*	Daniel E. McCarthy,	*Inspector.*
Lewis I. Nurenberg,	*Second Asst. Analyst.*	Frederick L. Marion,	*Inspector.*
Clarence E. Marsh,	*Third Asst. Analyst.*	Maurice P. Crowe,	*Inspector.*

The number of samples examined during this period, together with a summary of work done since the passage of the law in 1882, follows: —

Food and Drug Inspection (1882–1910).

Summary.	Years.	
	1910.	Total 1882–1910.
Number of samples of milk examined,	5,396	111,004
Number of samples above standard,	4,353	72,451
Number of samples below standard,	1,043	38,553
Number of samples of other kinds of food examined (not milk),	1,640	66,181
Number of samples of good quality,	1,308	53,978
Number of samples adulterated, as defined by the statutes,	332	12,203
Number of samples of drugs examined,	769	21,240
Number of samples of good quality,	617	13,957
Number of samples adulterated, as defined by the statutes,	152	7,283
Total examination of food and drugs,	7,805	198,425
Total samples of good quality,	6,278	140,386
Total samples not conforming to the statutes,	1,527	58,039

Section 7 of chapter 75 of the Revised Laws provides that the State Board of Health "shall annually report to the general court the number of prosecutions made under the provisions of sections sixteen to twenty-seven, inclusive, and an itemized account of the money expended in carrying out the provisions thereof;" and in accordance with this provision the following report is made.

The total number of prosecutions entered during the fiscal year ended Nov. 30, 1910, was 257. Of these, 244 resulted in conviction, 9 in acquittal; 1 was nol-prossed; and 1 was dismissed on motion of the inspector. Two other cases came to trial, but were dismissed by order of the court. There are 23 cases pending on appeal to the Superior Court.

The amount paid in fines was $5,395.21, which brings the sum total to $84,138.73.

PROSECUTIONS.

The following table presents the statistics relative to the prosecutions which have been conducted under the food and drug acts since the beginning of work in 1883 (Revised Laws, chapter 75, sections 16 to 27): —

Number of Complaints entered in Court.

YEAR.	Food and Other Articles (not including Milk).	Drugs.	Milk.	Total.	Convictions.	Fines imposed.
1883, ...	-	5	4	9	8	-[1]
1884, ...	2	1	45	48	44	-[1]
1885,[2]	50	1	68	119	103	-[1]
1886,[3]	10	-	10	20	19	-[1]
1887, ...	30	-	34	64	60	-[1]
1888, ...	22	-	43	65	61	$2,042 00
1889, ...	74	-	66	140	124	3,889 00
1890, ...	78	-	24	102	96	3,919 00
1891, ...	96	5	49	150	135	2,668 00
1892, ...	52	12	72	136	123	3,661 70
1893, ...	26	3	67	96	92	2,476 00
1894, ...	14	-	76	90	77	2,625 00
1895, ...	13	11	68	92	86	2,895 30
1896, ...	7	-	68	75	74	2,812 20
1897, ...	13	1	51	65	64	2,756 60
1898, ...	10	-	54	64	62	2,060 98
1899, ...	19	2	26	47	45	1,432 66
1900, ...	45	5	44	94	89	1,890 70
1901, ...	30	-	65	95	90	1,874 70
1902, ...	25	3	48	76	74	2,617 98
1903, ...	34	1	44	79	70	1,297 66
1904, ...	6	6	50	62	57	1,509 00
1905, ...	209	27	77	313	275	8,486 00
1906,[4]	177	60	171	409	383	7,316 00
1907, ...	123	63	147	333	290	6,546 00
1908, ...	76	138	219	433	386	8,300 30
1909, ...	72	44	180	296	267	5,666 74
1910, ...	112	26	119	257	244	5,395 21

[1] No record kept.

[2] To May 1, 1886.

[3] Four months only.

[4] Fourteen months, from Sept. 30, 1905.

The nature of the offences brought to the attention of the courts during the year, the names of the defendants, the places where the offences were committed, the dates of trial or indictment, and the results of the prosecutions, are set forth in the following table: —

For Sale of Milk not of Good Standard Quality.

Name.	Place.	Percentage of Total Solids.	Date.	Result.
Edward A. Butters, ...	Bedford, ...	10.80[1]	July 29, 1910	Conviction.
Samuel D. Allen, ...	Bellingham, . . .	6.00[2]	Mar. 5, 1910	Conviction.
Laurence B. Avery, ...	Beverly, ...	11.00[2]	Sept. 17, 1910	Conviction.[3]
Boston Dairy Co., ...	Boston, ...	10.46[1]	Nov. 30, 1910	Conviction.[3]
Boston Dairy Co., ...	Boston, ...	11.32[1]	Nov. 30, 1910	Conviction.[3]
H. P. Hood & Sons, ...	Boston, ...	9.66[4]	Jan. 28, 1910	Conviction.
Albert L. Forbush, ...	Braintree, ...	11.18[2]	Mar. 26, 1910	Conviction.
Albert L. Forbush, ...	Braintree, ...	10.28[2]	Mar. 26, 1910	Conviction.
Frank Hannaford, ...	Cambridge, . . .	11.90[1]	Feb. 15, 1910	Acquittal.
George Poulin, ...	Cambridge, . . .	11.38[1]	Feb. 15, 1910	Conviction.
Frank D. Taib, ...	Chicopee, ...	11.90	Apr. 22, 1910	Conviction.
Josephine Krug, ...	Dedham, ...	10.09[2]	Aug. 13, 1910	Conviction.
Jacob Wielock, ...	Dudley, ...	11.55	Jan. 20, 1910	Conviction.
Jacob Wielock, ...	Dudley, ...	11.55[2]	Jan. 20, 1910	Conviction.
Foster B. Phelps, ...	Princeton, ...	11.12	May 10, 1910	Conviction.[3]
Foster B. Phelps, ...	Princeton, ...	10.40[1]	May 10, 1910	Conviction.[3]
David A. Robinson, ...	Fitchburg, . . .	11.86[1]	Dec. 15, 1910	Conviction.
David A. Robinson, ...	Fitchburg, . . .	11.64[1]	Dec. 15, 1910	Conviction.
Herbert P. Pomeroy, ...	Framingham, . . .	11.36[2]	July 21, 1910	Conviction.
Delmer H. Morse, ...	Gardner, ...	9.50[1]	Jan. 6, 1910	Conviction.
Thomas W. Cole, ...	Gloucester, . . .	11.05[2]	Oct. 20, 1910	Conviction.[3]
Lemuel Friend, Jr., ...	Gloucester, . . .	10.60[2]	Oct. 20, 1910	Conviction.[3]
Gloucester Dairy Co., ...	Gloucester, . . .	10.00[2]	Oct. 13, 1910	Conviction.
William G. Lane, ...	Gloucester, . . .	11.58[2]	Oct. 28, 1910	Conviction.
James A. Lawrence, ...	Gloucester, . . .	7.88[2]	Oct. 20, 1910	Conviction.
James A. Lawrence, ...	Gloucester, . . .	11.30[2]	Oct. 20, 1910	Conviction.
John P. Madruga, ...	Gloucester, . . .	10.56[1]	Oct. 20, 1910	Conviction.
Mrs. Phillippa Madruga, . . .	Gloucester, . . .	11.50	Oct. 20, 1910	Conviction.
George E. Waldron, ...	Gloucester, . . .	11.40	Oct. 13, 1910	Conviction.[3]
William O. Jackson, ...	Hardwick, ...	10.58[2]	Nov. 28, 1910	Conviction.

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[1] Removal of cream alleged in complaint.

[2] Addition of water alleged in complaint.

[3] Appealed to upper court; case pending.

[4] Skimmed milk; cans not marked.

For Sale of Milk not of Good Standard Quality — Continued.

NAME.	Place.	Percentage of Total Solids.	Date.	Result.
Stephen Havey,	Hingham,	10.59[1]	Aug. 26, 1910	Conviction.
S. Westley Young,	Lawrence,	11.92	Apr. 28, 1910	Conviction.
S. Westley Young,	Lawrence,	11.26[2]	Apr. 28, 1910	Conviction.
John E. Willard,	Leominster,	10.75[1]	July 22, 1910	Conviction.
John E. Willard,	Leominster,	10.78[1]	July 22, 1910	Conviction.
Clarence H. Cutler,	Lexington,	9.24[2]	Apr. 26, 1910	Conviction.
William T. Hardy,	Lexington,	10.58[2]	Dec. 27, 1909	Conviction.
William T. Hardy,	Lexington,	11.32	Dec. 27, 1909	Conviction.
Gustav A. Peterson,	Lexington,	9.33[1]	Dec. 27, 1909	Conviction.
Gustav A. Peterson,	Lexington,	8.95[1]	Dec. 27, 1909	Conviction.
Evald Peterson,	Lexington,	10.90[1]	Sept. 19, 1910	Conviction.
Charles S. Smith,	Lincoln,	12.10[3]	July 29, 1910	Acquittal.
Amos P. Best,	Lowell,	11.72[1]	Sept. 12, 1910	Conviction.
Joseph Chenelle,	Lowell,	11.00[1]	Aug. 29, 1910	Conviction.
Michael Carvellas,	Lynn,	11.29[2]	May 31, 1910	Conviction.
Michael J. Collins,	Lynn,	7.82[1]	May 3, 1910	Conviction.
Frank Gomes,	Lynn,	11.96	May 3, 1910	Conviction.
H. P. Hood & Sons,	Lynn,	11.74	June 18, 1910	Conviction.[4]
H. P. Hood & Sons,	Lynn,	11.80	June 18, 1910	Conviction.
Frank S. McCarron,	Lynn,	11.30[1]	Nov. 9, 1910	Conviction.
William Nelson,	Lynn,	12.00[1]	Oct. 15, 1910	Conviction.
Winthrop M. Brown,	Lunenburg,	9.60[1]	Sept. 9, 1910	Conviction.[4]
John M. Cunningham,	Malden,	11.52[1]	Oct. 21, 1910	Conviction.
Edward E. Nichols,	Malden,	11.82	Oct. 21, 1910	Conviction.
Ernest M. Shute,	Malden,	11.75	Oct. 11, 1910	Conviction.[4]
Herbert H. Pope,	Marblehead,	10.02[2]	June 29, 1910	Conviction.
Herbert H. Pope,	Marblehead,	12.08	June 29, 1910	Conviction.
Alexander Bucci,	Melrose,	11.40[1]	Aug. 19, 1910	Conviction.
Harvey W. Forbes,	Melrose,	11.68	Oct. 11, 1910	Conviction.
Walter F. Beal,	Mendon,	11.46[1]	July 6, 1910	Conviction.
George H. Doe,	Milford,	10.50[1]	July 6, 1910	Conviction.
George H. Doe,	Milford,	9.70[1]	July 6, 1910	Conviction.
Hiram Miller,	Milford,	11.45[2]	Nov. 22, 1910	Conviction.
Hiram Miller,	Milford,	12.28[2]	Nov. 22, 1910	Conviction.
Edward E. Ford,	Milton,	9.66[1]	July 27, 1910	Conviction.

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[1] Addition of water alleged in complaint.

[2] Removal of cream alleged in complaint.

[3] Sale of dirty milk.

[4] Appealed to upper court; case pending.

For Sale of Milk not of Good Standard Quality — Continued.

NAME.	Place.	Percentage of Total Solids.	Date.	Result.
Charles Uniotes,	New Braintree,	10.56	May 2, 1910	Conviction.
Wm. C. Mackintosh,	Newburyport,	8.15[1]	Oct. 4, 1910	Pending.[2]
John C. Moynihan,	Newburyport,	11.36	Oct. 4, 1910	Conviction.
John Monaghan, Jr.,	Newton,	10.45[1]	Jan. 8, 1910	Conviction.
Charles M. Schultz,	Norfolk,	10.20[1]	Aug. 13, 1910	Conviction.
Michael J. Driscoll,	North Andover,	10.94[1]	Jan. 3, 1910	Acquittal.
Michael J. Driscoll,	North Andover,	10.94[1]	Jan. 3, 1910	Acquittal.
Maria Fagan,	Norton,	10.25[1]	May 4, 1910	Conviction.
Maria Fagan,	Norton,	11.61[1]	May 4, 1910	Conviction.
Willard Dean,	Norwood,	10.84	Dec. 2, 1909	Conviction.
Clay M. Nutting,	Pittsfield,	9.86[1]	Nov. 18, 1910	Conviction.
Harvey S. Smith,	Pittsfield,	11.78[1]	June 24, 1910	Conviction.
Joseph Teot,	Pittsfield,	11.33[1]	Dec. 17, 1909	Conviction.
George F. Knapp,	Quincy,	10.67[3]	Oct. 29, 1910	Conviction.
George Pawsey,	Quincy,	10.28[3]	Oct. 19, 1910	Conviction.
Julia H. Tracy,	Quincy,	10.79[1]	Oct. 19, 1910	Conviction.
Charles J. Nugent,	Rockport,	11.40[1]	Oct. 20, 1910	Conviction.[4]
Charles J. Campbell,	Rutland,	11.47[3]	Sept. 20, 1910	Acquittal.
Charles J. Campbell,	Rutland,	10.58[1]	Sept. 20, 1910	Acquittal.
Adam Robson,	Salem,	12.38[1]	Feb. 5, 1910	Conviction.
Charles Wineapple,	Salem,	9.60[1]	Aug. 6, 1910	Conviction.
Morris Wineapple,	Salem,	9.60[1]	Aug. 6, 1910	Conviction.
Mary Burns,	Saugus,	11.79	Dec. 7, 1909	Conviction.
Edward J. Fuller,	Sharon,	10.46[1]	Dec. 1, 1910	Conviction.
Frederick Tracy,	Shirley,	11.10[1]	Sept. 27, 1910	Conviction.
Manuel Simons,	Somerset,	9.63[1]	Aug. 23, 1910	Conviction.
Michael J. Gearan,	Springfield,	11.83[3]	May 3, 1910	Conviction.
Martin H. Healy,	Springfield,	10.80[3]	May 3, 1910	Conviction.
Samuel E. Smith,	Springfield,	11.34[3]	May 3, 1910	Conviction.
Byron L. Towne,	Springfield,	11.06[3]	May 12, 1910	Conviction.
John J. Dwyer,	Sudbury,	10.42[1]	July 23, 1910	Conviction.
Edwin A. Powers,	Sudbury,	6.83[1]	Mar. 26, 1910	Conviction.
Edwin A. Powers,	Sudbury,	6.80[1]	Mar. 26, 1910	Conviction.
Vener N. Paquette,	Swansea,	10.24[1]	Aug. 2, 1910	Conviction.
Antonio F. Durant,	Vineyard Haven,	11.45[1]	Sept. 1, 1910	Acquittal.
Lewis S. Hardy,	Waltham,	10.02[1]	Jan. 8, 1910	Conviction.

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[1] Addition of water alleged in complaint.

[2] Held for grand jury.

[3] Removal of cream alleged in complaint.

[4] Appealed to upper court; case pending.

For Sale of Milk not of Good Standard Quality — Concluded.

Name.	Place.	Percentage of Total Solids.	Date.	Result.
Winthrop H. Farnsworth,	Waltham,	8.97[1]	Aug. 12, 1910	Conviction.
Newton A. Clark,	Warren,	11.84	Jan. 7, 1910	Conviction.
Thomas Lindsey,	Watertown,	11.40[2]	Apr. 26, 1910	Conviction.
Emma F. Whitney,	Watertown,	11.20[2]	Apr. 26, 1910	Conviction.
S. Slater & Sons,	Webster,	12.10[2]	Jan. 27, 1910	Conviction.
S. Slater & Sons,	Webster,	12.10[2]	Jan. 27, 1910	Conviction.
Frank A. Perry,	Westport,	11.20[2]	Aug. 16, 1910	Conviction.
Henry H. Chamberlain,	Westwood,	11.00[2]	Dec. 2, 1909	Conviction.
Charles Meuse,	Weymouth,	11.40[2]	Nov. 30, 1910	Conviction.
Charles Meuse,	Weymouth,	11.46[2]	Nov. 30, 1910	Conviction.
Otto Reich,	Thompson, Conn.,	10.30[2]	Jan. 20, 1910	Conviction.
Otto Reich,	Thompson, Conn.,	9.99[2]	Jan. 20, 1910	Conviction.
John McLaughlin,	Providence, R. I.,	11.80[1]	Oct. 8, 1910	Conviction.
John McLaughlin,	Providence, R. I.,	11.80[1]	Oct. 8, 1910	Conviction.
Wollaston Blais,	Tiverton, R. I.,	10.70[2]	Sept. 9, 1910	Conviction.
Frank Sanders,	Tiverton, R. I.,	11.34[2]	Aug. 16, 1910	Dismissed.[3]
Howard W. Kee,	Warren, R. I.,	11.08[2]	Dec. 10, 1909	Conviction.
Howard W. Kee,	Warren, R. I.,	11.08[2]	Dec. 10, 1909	Conviction.

[1] Removal of cream alleged in complaint.
[2] Addition of water alleged in complaint.
[3] Dismissed for want of jurisdiction.

For Sale of Adulterated Cream.

Name.	Place.	Adulterant.	Date.	Result.
Edward E. Nichols,	Malden,	Low in fat,	Oct. 21, 1910	Conviction.

For Sale of Unmarked Renovated Butter.

Name.	Place.	Date.	Result.
Theodore Carellas,	Springfield,	May 3, 1910	Conviction.

For Sale of Oleomargarine as Butter.

NAME.	Place.	Date.	Result.
Frank Harrington,	Boston,	Mar. 31, 1910	Conviction.
George H. Kelton,	Boston,	Mar. 31, 1910	Conviction.
John T. Mansfield,	Cambridge,	May 19, 1910	Conviction.
Robert Field, Mgr.,	Chicopee,	Apr. 9, 1910	Conviction.
Charles A. Perry,	Chicopee,	May 12, 1910	Conviction.[1]
James E. Johnson,	Fall River,	Jan. 22, 1910	Conviction.
Wm. F. Houstin,	New Bedford,	May 6, 1910	Conviction.[1]
Arthur J. Hughes,	New Bedford,	Apr. 11, 1910	Conviction.[1]
Alexis Bragg,	Worcester,	Jan. 26, 1910	Conviction.
Wm. E. Megett,	Worcester,	Jan. 26, 1910	Conviction.
Wm. E. Megett,	Worcester,	Jan. 26, 1910	Conviction.

[1] Appealed to upper court; case pending.

For Sale of Adulterated Foods Other than Milk and Milk Products.

HAMBURG STEAK.

NAME.	Place.	Adulterant.	Date.	Result.
Benjamin Greenovitch,	Boston,	Sulphurous acid,	Mar. 1, 1910	Conviction.
Henry J. Manley,	Boston,	Sulphurous acid,	Sept. 27, 1910	Conviction.
George W. Maxim,	Brockton,	Sulphurous acid,	Jan. 14, 1910	Conviction.
Harry G. Snow,	Brockton,	Sulphurous acid,	Jan. 5, 1910	Conviction.
John Cavanaugh,	Lawrence,	Sulphurous acid,	Dec. 13, 1909	Conviction.
Gustav A. Yunggebauer,	Lawrence,	Sulphurous acid,	Dec. 13, 1909	Conviction.
Gustav A. Yunggebauer,	Lawrence,	Sulphurous acid,	Apr. 20, 1910	Conviction.
Arthur J. Hughes,	New Bedford,	Sulphurous acid,	Apr. 11, 1910	Nol-prossed.
Arthur J. Hughes,	New Bedford,	Sulphurous acid,	Apr. 11, 1910	Conviction.[1]

SAUSAGE.

NAME.	Place.	Adulterant.	Date.	Result.
L. Almon Johnson,	Boston,	Decomposed,	June 30, 1910	Conviction.
Charles H. Watson,	Fitchburg,	Corn starch,	Sept. 21, 1910	Conviction.
Morris Goldstein,	Pittsfield,	Cereal,	May 13, 1910	Conviction.
Herbert L. King,	Pittsfield,	Cereal,	May 13, 1910	Conviction.

SAUSAGE MEAT.

NAME.	Place.	Adulterant.	Date.	Result.
Arthur J. Stewart,	Springfield,	Wheat starch and corn,	Apr. 15, 1910	Conviction.
George C. Hodges,	Springfield,	Cereal,	May 3, 1910	Conviction.

[1] Appealed to upper court; case pending.

For Sale of Adulterated Foods Other than Milk and Milk Products — Continued.

PORK SAUSAGE.

NAME.	Place.	Adulterant.	Date.	Result.
Terrance McDonald,	Lowell,	Corn starch,	Mar. 29, 1910	Conviction.
James Smith,	Lowell,	Corn and wheat starch,	Apr. 15, 1910	Conviction.
Arthur J. Hughes,	New Bedford,	Wheat starch,	Apr. 11, 1910	Conviction.
Charles L. Thrasher,	Springfield,	Corn starch,	Apr. 21, 1910	Conviction.

LARD.

Frank Bevilacqua,	Boston,	Cotton-seed oil,	Mar. 30, 1910	Conviction.
Albert Cervizzi,	Boston,	Cotton-seed oil,	Mar. 17, 1910	Conviction.
Pasquale Diffilippo,	Boston,	Cotton-seed oil,	Mar. 30, 1910	Conviction.
Gaetano Gargano,	Boston,	Cotton-seed oil,	Mar. 30, 1910	Conviction.
Joseph Goldenberg,	Boston,	Cotton-seed oil,	Mar. 2, 1910	Conviction.
Jennie Milano,	Boston,	Cotton-seed oil,	Feb. 24, 1910	Conviction.
Nicholas Monahos,	Boston,	Cotton-seed oil,	Mar. 2, 1910	Conviction.
Dominic Naztro,	Boston,	Cotton-seed oil,	Mar. 30, 1910	Conviction.
Morris Oxman,	Boston,	Cotton-seed oil,	Mar. 2, 1910	Conviction.
Diano Pantoleon,	Boston,	Cotton-seed oil,	Mar. 29, 1910	Conviction.
Dominic Greger,	Brockton,	Cotton-seed oil,	Mar. 31, 1910	Conviction.
Kazimir Oksas,	Brockton,	Cotton-seed oil,	Mar. 24, 1910	Conviction.
Apostol Basdekis,	Chicopee,	Cotton-seed oil,	Apr. 22, 1910	Conviction.
Philip Belle-Isle,	Chicopee,	Cotton-seed oil,	Apr. 22, 1910	Conviction.
Josef Cylusnik,	Chicopee,	Cotton-seed oil,	Apr. 9, 1910	Conviction.
Louis Louison,	Fall River,	Cotton-seed oil,	Jan. 22, 1910	Conviction.
Bathasar Kojoyar,	Lawrence,	Cotton-seed oil,	Apr. 20, 1910	Conviction.
John F. Zajicek,	Lawrence,	Cotton-seed oil,	Apr. 28, 1910	Conviction.
George Flemming,	Lowell,	Cotton-seed oil,	Mar. 29, 1910	Conviction.
Joseph H. Flynn,	Lowell,	Cotton-seed oil,	Mar. 29, 1910	Conviction.
Terrance McDonald,	Lowell,	Cotton-seed oil,	Mar. 29, 1910	Conviction.
Frank Pinto,	Lowell,	Cotton-seed oil,	Mar. 29, 1910	Conviction.
Daniel Sullivan,	Lowell,	Cotton-seed oil,	Mar. 29, 1910	Conviction.
Alfred G. Alley,	New Bedford,	Cotton-seed oil,	Apr. 11, 1910	Conviction.
Joseph Boldric,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
Herbert W. Brightman,	New Bedford,	Cotton-seed oil,	Apr. 11, 1910	Conviction.
Alexander Donaghy,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
Alexander Donaghy,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
William Fanning,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
Patrick J. Flynn,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.

For Sale of Adulterated Foods Other than Milk and Milk Products — Continued.

LARD — Concluded.

NAME.	Place.	Adulterant.	Date.	Result.
Oscar Fricker,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
Wm. F. Houston,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
Arthur J. Hughes,	New Bedford,	Cotton-seed oil,	Apr. 11, 1910	Conviction.
Charles E. Jennings,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
Napoleon Jette,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
Stani Kivialkowski,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
Mates Kranzler,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
Joseph Lapolle,	New Bedford,	Cotton-seed oil,	Apr. 11, 1910	Conviction.
Philip Phoenix,	New Bedford,	Lard substitute, not marked.	Apr. 14, 1910	Conviction.
Arthur E. Robbins,	New Bedford,	Cotton-seed oil,	Apr. 11, 1910	Conviction.
Daniel Robinson,	New Bedford,	Cotton-seed oil,	Apr. 11, 1910	Conviction.
John Woodland,	New Bedford,	Cotton-seed oil,	Apr. 14, 1910	Conviction.
Morris Goldstein,	Pittsfield,	Cotton-seed oil,	May 13, 1910	Conviction.
Adolph Klein,	Pittsfield,	Cotton-seed oil,	May 13, 1910	Conviction.
Rafael Albano,	Springfield,	Cotton-seed oil,	May 3, 1910	Conviction.
James Dillon,	Springfield,	Cotton-seed oil,	Apr. 21, 1910	Conviction.
Patrick Fallon,	Springfield,	Cotton-seed oil,	Apr. 21, 1910	Conviction.
John F. Hughes,	Springfield,	Cotton-seed oil,	Apr. 21, 1910	Conviction.
Alexander Lanestti,	Springfield,	Cotton-seed oil,	Apr. 25, 1910	Conviction.
Joseph Pessolana,	Springfield,	Cotton-seed oil,	Apr. 21, 1910	Conviction.
Victor Buynicki,	Westfield,	Cotton-seed oil,	May 12, 1910	Conviction.
Simon M. Jegelwicz,	Westfield,	Cotton-seed oil,	May 12, 1910	Conviction.

MAPLE SUGAR.

NAME.	Place.	Adulterant.	Date.	Result.
New England Maple Syrup Co.	Cambridge,	Cane sugar,	May 4, 1910	Conviction.
New England Maple Syrup Co.	Cambridge,	Cane sugar,	May 4, 1910	Conviction.
Modeste Lamontagne,	Lawrence,	Cane sugar,	Apr. 28, 1910	Conviction.
Thomas Lagos,	Salem,	Cane sugar,	Feb. 18, 1910	Conviction.
Peter Stasinopulos,	Salem,	Cane sugar,	Feb. 18, 1910	Conviction.

OLIVE OIL.

NAME.	Place.	Adulterant.	Date.	Result.
Albert Cervizzi,	Boston,	Cotton-seed oil,	Mar. 17, 1910	Conviction.
Giacomo Dell Aria,	Boston,	Cotton-seed oil,	Mar. 30, 1910	Conviction.
Dominick Di Sciello,	Boston,	Cotton-seed oil,	Sept. 27, 1910	Conviction.
Nicholas Karabelas,	Boston,	Cotton-seed oil,	Feb. 25, 1910	Acquittal.
Nicholas Monahos,	Boston,	Cotton-seed oil,	Mar. 2, 1910	Conviction.

For Sale of Adulterated Foods Other than Milk and Milk Products — Concluded.

Olive Oil — Concluded.

Name.	Place.	Adulterant.	Date.	Result.
Dominic Nastro,	Boston,	Cotton-seed oil,	Mar. 30, 1910	Conviction.
Antonio Previte,	Boston,	Cotton-seed oil,	Apr. 8, 1910	Conviction.
Frank Priore,	Boston,	Cotton-seed oil,	Apr. 8, 1910	Dismissed.[1]
Guiseppe Tucci,	Boston,	Cotton-seed oil,	Feb. 25, 1910	Conviction.
Guiseppe Zuffante,	Boston,	Cotton-seed oil,	Feb. 25, 1910	Conviction.
Guiseppe Zuffante,	Boston,	Cotton-seed oil,	Feb. 25, 1910	Conviction.
Guiseppe Zuffante,	Boston,	Cotton-seed oil,	- -	Dismissed.[2]
Guiseppe Zuffante,	Boston,	Cotton-seed oil,	Feb. 25, 1910	Conviction.
Dominica P. Araldo,	Brockton,	Cotton-seed oil,	Jan. 25, 1910	Conviction.
Ahmous Abdullah,	Lowell,	Cotton-seed oil,	Mar. 29, 1910	Conviction.
Antonio Chaccio,	Newton,	Cotton-seed oil,	Mar. 14, 1910	Conviction.
Alexander Lanestti,	Springfield,	Cotton-seed oil,	Apr. 25, 1910	Conviction.
Rafael Albano,	Springfield,	Cotton-seed oil,	May 3, 1910	Conviction.

Peanuts.

Harry Cohen,	Boston,	Decomposed,	Oct. 7, 1910	Conviction.

Rolled Wheat.

Cobb, Bates & Yerxa,	Boston,	Contained dead insects,	Nov. 29, 1910	Conviction.

Vinegar.

Arthur Lord,	Fall River,	Distilled, sold for cider vinegar.	Sept. 9, 1910	Conviction.
James P. Galligan Co.,	Taunton,	Distilled; artificially colored.	Oct. 6, 1910	Conviction.

Wine Vinegar.

Peter Bacicalupo,	Boston,	Acidity below legal standard.	Mar. 30, 1910	Conviction.
Andrea DiPietro,	Boston,	Acidity below legal standard.	Mar. 30, 1910	Conviction.

For Sale of Adulterated Drugs.

Alcohol.

Quinlan Leary,	Fall River,	Water,	Aug. 2, 1910	Conviction.
John T. Murphy,	Fall River,	Water,	Aug. 2, 1910	Conviction.

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[1] Dismissed for want of prosecution.

[2] Dismissed without trial.

For Sale of Adulterated Drugs — Concluded.

COCAINE HYDROCHLORIDE.

NAME.	Place.	Adulterant.	Date.	Result.
James J. Cramer, . .	Boston, . .	Sold without prescription.	Mar. 2, 1910	Conviction.

CAMPHOR LINIMENT.

NAME.	Place.	Adulterant.	Date.	Result.
Arthur Burnside, . .	Boston, . .	Deficiency in strength,	Aug. 17, 1910	Conviction.
Herbert F. Verder, . .	Boston, . .	Deficiency in strength,	Aug. 17, 1910	Conviction.

SPIRIT OF ANISE.

NAME.	Place.	Adulterant.	Date.	Result.
Frank J. McGarry, . .	Boston, . .	Deficiency in strength,	Mar. 30, 1910	Acquittal.
John W. Patch, . . .	Boston, . .	Deficiency in strength,	Feb. 24, 1910	Conviction.
John E. Blake, . . .	Brockton, .	Deficiency in strength,	Mar. 10, 1910	Conviction.[1]
Ernest A. Carlson, . .	Brockton, .	Deficiency in strength,	Jan. 25, 1910	Conviction.
Chas. H. Goldthwait, .	Brockton, .	Deficiency in strength,	Mar. 31, 1910	Conviction.[1]
Arthur M. Kelsey, . .	Brockton, .	Deficiency in strength,	Mar. 10, 1910	Conviction.[1]
Chas. N. Swift, . . .	Brockton, .	Deficiency in strength,	Mar. 12, 1910	Conviction.[1]
George B. Ketchum, . .	Cambridge, .	Deficiency in strength,	May 19, 1910	Conviction.
Joseph O. Guimond, . .	Chicopee, . .	Deficiency in strength,	Apr. 22, 1910	Conviction.
Chas. H. King, . . .	Chicopee, . .	Deficiency in strength,	Apr. 9, 1910	Conviction.
Walter J. Keating, . .	Lawrence. .	Deficiency in strength,	May 11, 1910	Conviction.
Albert B. Kelley, . .	Lawrence, .	Deficiency in strength,	May 11, 1910	Conviction.[1]
Forrest E. Beal, . . .	Lowell, . .	Deficiency in strength,	Apr. 15, 1910	Conviction.
Pierre N. Burwell, . .	Lowell, . .	Deficiency in strength,	Apr. 15, 1910	Conviction.
Azro W. Dows, . . .	Lowell, . .	Deficiency in strength,	Apr. 15, 1910	Conviction.
Hall & Lyon, . . .	Lowell, . .	Deficiency in strength,	Mar. 29, 1910	Conviction.[1]
Frank E. McNabb, . .	Lowell, . .	Deficiency in strength,	Apr. 15, 1910	Conviction.
Edward F. Fahey, . .	Pittsfield, .	Deficiency in strength,	June 24, 1910	Conviction.
Thomas H. Farrell, . .	Pittsfield, . .	Deficiency in strength,	June 24, 1910	Conviction.

TINCTURE OF GINGER.

NAME.	Place.	Adulterant.	Date.	Result.
Arthur L. Gavin, . .	Boston, . .	Deficiency in strength,	Jan. 17, 1910	Conviction.

TINCTURE OF IODINE.

NAME.	Place.	Adulterant.	Date.	Result.
Arthur Burnside, . .	Boston, . .	Deficiency in strength,	Aug. 17, 1910	Conviction.

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[1] Appealed to upper court; case pending.

Of the cases reported as pending in the last preceding report, 11 for the sale of adulterated milk resulted in conviction and fine and 3 were placed on file; 1 other case was tried twice, the jury disagreeing at each trial. One case for the sale of adulterated drugs also resulted in conviction and fine.

Seven cases for the sale of adulterated milk, pending in 1908, have come to trial during the past year. Five resulted in conviction and fine, 1 was placed on file and 1 was nol-prossed.

The amount paid in fines was $5,395.21, as follows: —

Milk and milk products,	$3,443 26
Foods other than above,	1,557 40
Drugs,	394 55
	$5,395 21

The total number of samples of food, drugs, liquors and poisons examined during the year was as follows: —

Milk,	5,396
Food,	1,640
Drugs,	769
Liquors,	108
Poisons,	21
	7,934

Expenditures under the Provisions of the Food and Drug Acts for the Year ended Nov. 30, 1910.

Appropriation,	$14,500 00
Salaries of analysts,	$5,500 00
Salaries of inspectors,	5,206 05
Traveling expenses and purchase of samples,	2,903 06
Apparatus and chemicals,	324 63
Printing,	52 20
Services, cleaning laboratory,	104 00
Express and telephone,	23 64
Sundry laboratory supplies,	152 39
Books, binding and stationery,	27 45
Extra services,	182 32
Advertising,	23 38
Total,	$14,499 12

REPORT OF THE ANALYST.

By Hermann C. Lythgoe.

REPORT OF THE ANALYST.

By HERMANN C. LYTHGOE.

Dr. MARK W. RICHARDSON, *Secretary of the Massachusetts State Board of Health.*

DEAR SIR: — I herewith submit my report on the analysis of food and drugs for the year ending Nov. 30, 1910.

MILK AND MILK PRODUCTS.

Five thousand three hundred and ninety-six samples of milk were examined during the year, of which 1,043 were below the standard and 243 samples were declared adulterated. The usual statistics of milk are as follows: —

Milk from Cities.

LOCALITY.	Above Standard.	Below Standard.	Total Samples collected.	TOTAL SOLIDS (PER CENT.).		FAT (PER CENT.).		Samples marked Skimmed.	ADULTERATED SAMPLES.		AVERAGE OF SAMPLES NOT DECLARED SKIMMED OR WATERED (PER CENT.).		
				Highest Sample.	Lowest Sample.	Highest Sample.	Lowest Sample.		Skimmed.	Watered.	Solids.	Fat.	Solids not Fat.
Beverly,	51	10	61	14.50	9.60	5.10	0.40	2	1	-	12.86	4.06	8.80
Boston,	7	-	7	13.08	12.32	3.90	3.50	-	-	-	12.59	3.68	8.91
Brockton,	111	22	133	17.20	10.30	8.20	1.60	-	2	1	13.01	4.15	8.86
Cambridge,	165	23	188	13.70	11.30	5.00	2.50	-	1	-	12.57	3.78	8.79
Chelsea,	67	2	69	14.00	11.40	4.80	2.40	-	1	-	12.63	3.86	8.77
Chicopee,	13	3	16	14.50	11.42	5.20	3.15	-	-	-	12.73	4.07	8.66
Everett,	26	3	29	13.70	11.90	5.20	2.70	-	1	-	12.64	3.86	8.78
Fall River,	84	23	107	15.57	10.23	6.40	2.75	-	-	6	12.68	4.07	8.61
Fitchburg,	31	23	54	14.07	9.46	4.80	0.20	1	-	5	12.45	3.85	8.65
Gloucester,	81	38	119	15.60	7.88	9.00	2.10	-	1	12	12.49	3.92	8.57
Haverhill,	16	2	18	13.46	12.08	4.80	3.30	-	-	-	12.82	4.05	8.77
Holyoke,	36	8	44	14.30	11.11	4.80	3.00	-	-	-	12.48	3.70	8.78
Lawrence,	119	29	148	14.72	9.10	6.20	0.10	1	3	-	12.65	3.94	8.71
Lowell,	134	50	184	16.80	10.50	8.20	2.65	-	1	6	12.59	3.79	8.80
Lynn,	204	51	255	15.32	7.82	5.95	2.05	-	2	11	12.87	4.01	8.86
Malden,	110	23	133	14.46	10.50	5.20	2.50	-	1	2	12.63	3.81	8.82
Marlborough,	68	7	75	14.80	8.94	5.80	0.30	2	-	-	13.05	4.08	8.97
Medford,	66	27	93	14.10	10.50	4.80	1.80	1	1	-	12.48	3.78	8.70
Melrose,	51	2	53	13.90	11.40	4.80	3.40	-	1	-	12.84	3.95	8.89

New Bedford, ...	65	9	74	18.80	11.54	9.95	3.00	-	-	1	13.12	4.14	8.98
Newburyport, ...	105	14	119	15.90	8.15	7.90	0.20	2	-	1	13.08	4.26	8.82
Newton, ...	56	10	66	14.28	8.98	5.40	2.60	-	-	5	12.84	3.95	8.89
North Adams, ...	42	5	47	15.40	10.40	6.40	2.80	-	-	5	13.35	4.48	8.87
Pittsfield, ...	106	7	113	15.20	9.50	5.60	0.20	3	-	5	13.33	4.22	9.11
Quincy, ...	38	11	49	15.76	8.74	5.60	2.00	-	4	4	12.92	4.39	8.53
Salem, ...	81	18	99	14.50	9.60	5.60	2.85	-	-	2	12.81	4.03	8.78
Somerville, ...	120	9	129	14.40	10.46	5.25	2.30	-	2	-	12.71	3.88	8.83
Springfield, ...	119	16	135	17.20	10.80	9.00	2.40	-	4	-	12.79	3.98	8.81
Taunton, ...	75	6	81	17.56	9.48	7.90	0.20	3	-	-	13.62	4.82	8.80
Waltham, ...	71	17	88	15.44	8.97	6.75	0.10	2	3	-	12.70	3.86	8.84
Woburn, ...	6	4	10	13.50	10.06	4.30	2.30	-	1	-	11.03	3.45	8.58
Worcester, ...	13	2	15	14.40	10.10	4.80	0.30	1	1	-	12.94	3.87	9.07
Totals, ...	2,337	474	2,811	18.80	7.82	9.95	0.10	18	31	66	12.80	4.00	8.80

Milk from Towns.

LOCALITY.	Above Standard.	Below Standard.	Total Samples collected.	TOTAL SOLIDS (PER CENT.).		FAT (PER CENT.).		Samples marked Skimmed.	ADULTERATED SAMPLES.		AVERAGE OF SAMPLES NOT DECLARED SKIMMED OR WATERED (PER CENT.).		
				Highest Sample.	Lowest Sample.	Highest Sample.	Lowest Sample.		Skimmed.	Watered.	Solids.	Fat.	Solids not Fat.
Adams,	25	3	28	13.94	11.44	5.00	2.90	-	-	-	12.73	4.04	8.69
Amesbury,	16	-	16	14.70	12.54	5.60	3.75	-	-	-	13.42	4.39	9.03
Andover,	9	7	16	13.00	11.53	4.10	3.25	-	-	-	12.59	3.73	8.86
Abington,	12	-	12	13.20	12.20	4.20	3.60	-	-	-	12.49	3.93	8.56
Ashland,	17	4	21	11.60	11.31	5.00	3.10	-	-	-	12.82	3.82	9.00
Athol,	15	-	15	14.20	12.42	5.20	3.50	-	-	-	13.57	4.49	9.08
Attleborough,	56	6	62	15.60	11.20	6.10	2.40	1	-	-	13.24	4.41	8.83
Bedford,	11	18	29	13.30	10.80	4.70	2.30	-	1	-	12.09	3.67	8.42
Beverly,	51	10	61	14.50	9.60	5.10	0.40	2	1	-	12.86	4.06	8.80
Billerica,	12	12	24	12.76	10.70	4.20	3.00	-	-	-	12.19	3.35	8.84
Blackstone,	15	3	18	14.58	11.80	5.10	2.95	-	-	-	12.64	3.88	8.76
Braintree,	25	7	32	17.60	10.28	7.60	3.00	-	-	5	13.67	4.66	9.01
Bridgewater,	10	1	11	14.40	9.56	5.60	0.20	1	-	-	13.26	4.25	9.01
Brookline,	13	3	16	17.20	11.58	9.20	2.80	-	-	-	12.68	4.08	8.60
Canton,	28	2	30	14.40	11.42	5.00	2.80	-	-	-	13.13	4.08	9.05
Clinton,	6	-	6	13.90	9.47	4.10	0.20	2	-	-	12.95	3.82	9.13
Concord,	13	8	21	13.20	11.56	4.40	2.95	-	-	-	12.27	3.67	8.60
Dalton,	10	-	10	14.86	9.31	5.00	0.80	2	-	-	13.30	4.29	9.01
Danvers,	34	11	45	13.74	11.62	4.50	2.95	-	-	-	12.74	3.68	9.06

Dedham, ...	21	1	22	16.28	12.00	7.60	3.70	-	-	-	13.24	4.40	8.84
Dighton, ...	9	3	12	14.10	11.50	4.50	2.75	-	-	-	12.74	3.59	8.85
Dracut, ...	10	7	17	13.46	11.20	5.00	2.60	-	-	-	12.19	3.73	8.46
Duxbury, ...	4	-	4	13.80	12.44	4.70	3.60	-	-	-	13.34	4.30	9.04
Easthampton, . . .	14	2	16	14.10	9.54	4.80	0.10	3	-	-	13.29	4.41	8.88
Easton, ...	19	7	26	14.97	9.94	5.50	2.55	-	4	-	12.93	4.20	8.73
Edgartown, ...	8	2	10	15.00	11.90	5.50	3.25	-	-	-	13.25	4.43	8.82
Fairhaven, ...	3	2	5	13.95	12.06	5.10	3.10	-	-	-	12.60	3.78	8.82
Falmouth, ...	6	1	7	15.36	11.27	6.10	2.80	-	-	-	13.83	4.71	9.12
Framingham, . . .	17	2	19	14.50	11.36	4.85	3.30	-	-	1	12.96	4.08	8.88
Franklin, ...	3	-	3	13.65	12.68	4.70	3.83	-	-	-	13.12	4.18	8.94
Great Barrington, . .	11	1	12	14.17	11.90	5.20	3.80	-	-	1	13.63	4.41	9.22
Greenfield, ...	17	2	19	14.60	11.80	4.90	3.60	-	-	-	13.02	4.17	8.85
Halifax, ...	5	1	6	13.51	11.90	4.50	3.30	-	-	-	13.01	4.08	8.93
Hingham, ...	38	9	47	14.20	9.76	4.80	0.40	1	-	2	12.82	4.02	8.80
Holyoke, ...	36	8	44	14.30	11.11	4.80	3.00	-	-	-	12.48	3.70	8.78
Hopkinton, ...	2	-	2	13.60	13.44	4.30	4.00	-	-	-	13.52	4.15	9.37
Hudson, ...	8	1	9	13.20	12.10	4.10	3.40	-	-	-	12.69	3.86	8.83
Hull, ...	2	3	5	12.80	12.00	3.90	3.35	-	-	-	12.03	3.55	8.48
Hyde Park, ...	64	11	75	14.86	10.80	5.60	2.50	-	3	-	12.88	3.97	8.91
Ipswich, ...	29	5	34	14.00	11.60	5.00	3.00	-	-	1	12.81	4.13	8.68
Kingston, ...	1	3	4	12.84	9.48	4.80	3.20	-	-	3	12.84	3.80	9.04
Lee, ...	7	1	8	13.70	10.00	4.70	0.80	1	-	-	13.09	4.17	8.92
Lenox, ...	13	-	13	16.00	13.00	6.90	3.80	-	-	-	14.08	4.83	9.25
Leominster, ...	39	4	43	14.80	10.76	6.30	2.50	-	1	-	12.95	4.12	8.83

Milk from Towns — Continued.

LOCALITY.	Above Standard.	Below Standard.	Total Samples collected.	TOTAL SOLIDS (PER CENT.).		FAT (PER CENT.).		Samples marked Skimmed.	ADULTERATED SAMPLES.		AVERAGE OF SAMPLES NOT DECLARED SKIMMED OR WATERED (PER CENT.).		
				Highest Sample.	Lowest Sample.	Highest Sample.	Lowest Sample.		Skimmed.	Watered.	Solids.	Fat.	Solids not Fat.
Lexington,	11	7	18	13.60	10.12	4.60	2.90	-	-	1	12.51	3.85	8.66
Lincoln,	41	12	53	14.58	11.40	4.70	3.00	-	-	-	12.37	3.66	8.71
Ludlow,	11	3	14	13.20	11.85	4.05	3.40	-	-	-	12.40	3.80	8.60
Marblehead,	27	5	32	14.18	10.02	4.90	1.60	-	1	-	12.93	4.10	8.83
Marshfield,	1	1	2	13.20	11.80	4.80	4.00	-	-	1	13.20	4.80	8.40
Maynard,	33	17	50	13.48	11.00	4.70	2.95	-	-	1	12.56	3.80	8.76
Mendon,	13	-	13	14.40	12.66	5.00	3.60	-	-	-	13.29	4.23	9.06
Methuen,	3	1	4	13.30	11.64	4.70	3.40	-	-	-	12.88	4.20	8.68
Middleborough,	14	2	16	16.00	11.48	6.60	3.10	-	-	-	13.57	4.70	8.87
Milford,	60	14	74	15.46	8.10	5.40	2.20	-	1	6	13.10	4.02	9.08
Montague,	15	-	15	14.40	12.26	5.50	3.70	-	-	-	13.54	4.55	8.99
Nantucket,	24	2	26	14.56	9.82	5.20	1.30	1	1	-	13.49	4.74	8.75
Natick,	55	6	61	14.40	9.64	4.70	0.20	3	-	-	13.04	4.02	9.02
Needham,	9	1	10	13.30	12.00	4.40	3.25	-	-	-	12.89	3.94	8.95
North Attleborough,	29	2	31	14.62	9.40	5.40	0.20	2	-	-	13.14	4.22	8.92
Norton,	15	3	18	14.05	11.64	4.80	3.00	-	-	-	12.99	3.71	9.28
Norwood,	8	1	9	13.88	11.38	4.85	3.20	-	-	-	12.61	3.87	8.74
Oak Bluffs,	22	11	33	15.26	11.26	5.80	2.70	-	-	-	13.11	4.15	8.96
Peabody,	20	1	21	14.08	11.96	5.25	3.70	-	-	-	13.01	4.19	8.82

Plymouth, ...	22	7	29	15.38	10.40	4.80	0.70	1	-	1	12.86	4.09	8.77
Plympton, ...	3	2	5	10.54	11.09	3.80	2.80	-	-	-	11.01	3.24	8.57
Provincetown, . . .	19	4	23	15.60	11.00	6.80	2.60	-	-	-	12.90	4.21	8.69
Reading, ...	23	-	23	14.74	12.20	5.40	3.50	-	-	-	13.17	4.20	8.97
Revere, ...	15	1	16	12.70	12.10	3.85	3.10	-	-	-	12.41	3.63	8.78
Rockland, ...	6	1	7	14.92	12.02	5.60	3.05	-	-	-	13.44	4.41	9.03
Rockport, ...	10	1	11	15.20	12.00	6.10	3.70	-	-	-	12.78	4.26	8.52
Salisbury, ...	17	11	28	13.84	11.24	5.00	3.00	-	-	-	12.84	3.87	8.97
Saugus, ...	13	-	13	13.94	12.30	4.70	3.40	-	-	-	12.90	3.86	9.04
Shelburne, ...	11	-	11	15.60	12.50	6.20	3.30	-	-	-	13.99	4.65	9.34
Southbridge, . . .	16	4	20	16.20	10.90	6.90	2.30	-	1	-	12.98	4.16	8.82
South Hadley, . . .	12	-	12	13.00	12.64	4.20	3.90	-	-	-	12.95	4.08	8.87
Sterling, ...	5	3	8	14.30	11.73	5.20	3.30	-	-	-	12.95	4.30	8.65
Stoneham, ...	6	4	10	13.10	11.90	4.20	3.60	-	-	-	12.33	3.84	8.49
Stoughton, ...	16	2	18	14.60	9.80	5.30	0.05	1	-	-	13.26	4.26	9.00
Swampscott, . . .	7	-	7	14.20	12.72	4.80	4.20	-	-	-	13.36	4.34	9.02
Templeton, ...	13	-	13	14.86	12.68	5.20	3.70	-	-	-	13.45	4.29	9.16
Topsfield, ...	14	1	15	13.40	11.60	4.90	3.60	-	-	-	12.62	4.16	8.46
Vineyard Haven, . .	20	3	23	17.22	11.45	8.30	2.80	-	1	1	13.88	4.98	8.90
Wakefield, ...	20	2	22	13.26	11.65	4.20	3.40	-	-	-	12.52	3.78	8.74
Walpole, ...	4	1	5	13.56	12.10	4.40	3.80	-	-	-	13.05	4.08	8.97
Ware, ...	9	6	15	13.94	11.70	4.70	3.15	-	-	-	12.48	3.68	8.80
Watertown, ...	18	9	27	13.64	9.24	4.90	0.20	1	1	1	12.51	3.79	8.72
Webster, ...	37	8	45	15.22	6.50	6.40	0.35	1	-	9	13.36	4.32	9.04
Wellesley, ...	10	1	11	14.00	11.24	5.00	2.25	1	-	-	12.95	4.18	8.77

Milk from Towns — Concluded.

LOCALITY.	Above Standard.	Below Standard.	Total Samples collected.	TOTAL SOLIDS (PER CENT.).		FAT (PER CENT.).		Samples marked Skimmed.	ADULTERATED SAMPLES.		AVERAGE OF SAMPLES NOT DECLARED SKIMMED OR WATERED (PER CENT.).		
				Highest Sample.	Lowest Sample.	Highest Sample.	Lowest Sample.		Skimmed.	Watered.	Solids.	Fat.	Solids not Fat.
Westborough, ...	11	1	12	16.40	11.07	6.10	3.10	-	-	-	13.15	4.00	9.15
Westfield, ...	12	3	15	13.40	11.68	4.20	3.20	-	-	-	12.71	3.93	8.78
West Springfield, . . .	7	7	14	15.37	11.20	5.90	3.10	-	-	-	12.46	3.68	8.78
Weymouth, ...	29	3	32	14.10	11.40	6.00	3.50	-	-	2	13.52	4.59	8.93
Whitman, ...	32	5	37	14.40	11.40	5.00	3.00	-	-	-	13.17	4.07	9.10
Williamstown, . . .	12	1	13	14.32	9.40	5.20	0.40	1	-	-	13.09	4.23	8.86
Wilmington, . . .	2	-	2	13.07	12.90	4.40	4.00	-	-	-	12.99	4.30	8.69
Winchester, ...	30	3	33	15.00	11.93	5.30	3.30	-	-	-	12.69	3.87	8.82
Winthrop, ...	15	-	15	13.02	12.30	4.10	3.55	-	-	-	12.78	3.92	8.86
Totals, ...	1,620	344	1,964	17.60	8.10	9.31	0.05	23	15	36	12.96	4.04	8.92

Milk from Suspected Producers.

LOCALITY.	Above Standard.	Below Standard.	Total Samples collected.	TOTAL SOLIDS (PER CENT.).		FAT (PER CENT.).		ADULTERATED SAMPLES.		AVERAGE OF SAMPLES NOT DECLARED SKIMMED OR WATERED (PER CENT.).		
				Highest Sample.	Lowest Sample.	Highest Sample.	Lowest Sample.	Skimmed.	Watered.	Solids.	Fat.	Solids not Fat.
Acton,	19	14	33	14.00	11.10	4.60	2.65	-	-	12.37	3.64	8.73
Andover,	5	-	5	13.60	12.72	4.35	3.90	-	-	13.20	4.13	9.07
Bellingham,	1	2	3	12.60	6.00	4.40	1.35	-	2	12.60	4.40	8.20
Belmont,	5	4	9	12.58	11.50	3.80	3.10	-	-	12.11	3.56	8.55
Beverly,	18	8	26	13.50	11.00	4.90	3.00	-	1	12.41	3.94	8.47
Burlington,	9	4	13	14.30	10.60	5.60	2.80	-	-	12.25	3.75	8.50
Cambridge,	5	-	5	12.67	12.26	3.90	3.35	-	-	12.42	3.68	8.74
Charlton,	-	5	5	11.30	10.80	3.05	2.70	-	-	11.01	2.90	8.11
Danvers,	15	6	21	13.88	11.58	4.30	3.40	-	-	12.59	4.09	8.50
Dedham,	1	6	7	12.28	10.09	3.80	3.10	-	7	-	-	-
Gardner,	27	1	28	14.20	11.59	4.90	3.00	-	-	13.16	4.10	9.06
Granby,	46	-	46	13.86	12.24	4.60	3.50	-	-	12.83	3.88	8.95
Hardwick,	3	18	21	13.50	10.58	5.80	2.20	-	8	11.30	3.14	8.16
Ipswich,	6	-	6	13.40	12.20	4.15	3.55	-	-	12.91	3.92	8.99
Kingston,	10	6	16	15.36	10.72	5.10	3.10	-	-	12.66	3.76	8.90
Lexington,	7	5	12	15.60	9.80	6.30	3.20	-	6	13.45	4.65	8.80
Longmeadow,	13	2	15	16.54	12.10	6.30	3.70	-	-	13.46	4.46	9.00
Lunenburg,	1	8	9	12.80	9.36	4.00	2.60	-	8	12.80	4.00	8.80
Marshfield,	12	6	18	13.61	11.80	4.40	3.20	-	-	12.46	3.80	8.66

Milk from Suspected Producers — Concluded.

LOCALITY.	Above Standard.	Below Standard.	Total Samples collected.	Total Solids (Per Cent.).		Fat (Per Cent.).		Adulterated Samples.		Average of Samples not declared Skimmed or Watered (Per Cent.).		
				Highest Sample.	Lowest Sample.	Highest Sample.	Lowest Sample.	Skimmed.	Watered.	Solids.	Fat.	Solids not Fat.
Maynard,	1	5	6	13.60	6.80	4.50	2.00	-	4	13.00	4.10	8.90
Medfield,	2	4	6	12.51	10.20	4.20	2.90	-	2	11.73	3.75	7.98
Milton,	-	21	21	10.90	9.66	3.40	2.40	-	21	-	-	-
Oxford,	18	-	18	13.24	12.80	4.00	3.70	-	-	13.06	3.70	9.36
Peabody,	17	-	17	14.20	12.16	5.00	3.40	-	-	13.05	4.16	8.89
Princeton,	-	5	5	11.66	10.40	3.15	2.00	4	-	11.66	3.15	8.51
Rowley,	7	3	10	13.68	11.40	4.45	3.25	-	-	12.74	3.84	8.90
Rutland,	-	3	3	11.67	10.58	3.80	2.70	1	2	-	-	-
Saugus,	-	17	17	12.12	11.60	3.50	3.20	-	-	11.88	3.37	8.51
Shirley,	-	2	2	11.22	11.10	4.20	3.20	-	2	-	-	-
Somerset,	-	10	10	10.80	9.63	3.50	3.30	-	10	-	-	-
Stow,	9	-	9	14.20	12.56	4.90	3.70	-	-	13.35	4.16	9.19
Sudbury,	21	9	30	14.58	10.42	5.20	2.70	-	6	12.72	4.00	8.72
Wakefield,	15	-	15	13.40	12.40	4.20	3.40	-	-	12.75	3.80	8.95
Walpole,	8	1	9	14.70	11.66	5.10	3.05	-	-	13.42	4.32	9.10
Warren,	12	-	12	13.64	12.82	4.80	4.00	-	-	13.26	4.39	8.87
Watertown,	3	4	7	15.48	10.40	6.50	3.40	-	4	14.12	5.23	8.89
Westport,	17	14	31	13.90	11.10	5.70	2.95	-	4	12.26	3.86	8.40
West Springfield,	6	15	21	12.40	11.66	3.85	3.35	-	-	11.95	3.50	8.45
Totals,	339	208	547	16.54	6.00	6.50	1.35	5	87	12.63	3.88	8.75

Summary of Milk Statistics.

LOCALITY.	Above Standard.	Below Standard.	Total Samples collected.	TOTAL SOLIDS (PER CENT.).		FAT (PER CENT.).		Samples marked skimmed.	ADULTERATED SAMPLES.		AVERAGE OF SAMPLES NOT DECLARED SKIMMED OR WATERED (PER CENT.).		
				Highest Sample.	Lowest Sample.	Highest Sample.	Lowest Sample.		Skimmed.	Watered.	Solids.	Fat.	Solids not Fat.
Milk from cities, . . .	2,337	474	2,811	18.80	7.82	9.95	0.10	18	31	66	12.80	4.00	8.80
Milk from towns, . .	1,620	344	1,964	17.60	8.10	9.31	0.05	23	15	36	12.96	4.04	8.92
Milk from suspected producers.	339	208	547	16.54	6.00	5.60	1.35	-	5	87	12.63	3.88	8.75
Miscellaneous, . . .	57	17	74	-	-	-	-	-	-	3	-	-	-
Totals, ...	4,353	1,043	5,396	18.80	6.00	9.95	0.05	41	51	192	12.85	4.02	8.83

Milk containing Added Water.

DEALER.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
Walter F. Adams,	Fitchburg,	10.22	2.80	7.42	34.0
Samuel D. Allen,	Bellingham,	6.00	1.35	4.65	24.7
		10.73	3.00	7.73	35.2
Lawrence B. Avery,	Beverly,	11.00	3.25	7.75	35.2
Leondas Ballard,	Dudley,	6.50	0.40	6.10	30.9
		4.70	0.50	4.20	27.6
George T. Barker,	Wollaston,	8.74	2.40	6.34	31.8
W. I. Beal,	Milford,	11.46	3.40	8.06	35.3
D. Bergeroni,	Brockton,	10.66	3.30	7.36	35.0
Amos P. Best,	Dracut,	11.72	4.15	7.57	35.7
Wallaston Blais,	Tiverton, R. I.,	10.70	3.20	7.50	34.3
Winthrop Brown,	Lunenburg,	9.60	2.75	6.85	34.3
		9.86	3.00	6.86	34.6
		11.00	3.45	7.55	35.0
		10.00	2.85	7.15	34.7
		10.26	3.10	7.16	34.0
		10.70	3.20	7.50	35.0
		9.36	2.70	6.66	33.4
Alexander Bucci,	Melrose,	11.40	3.40	8.00	35.4
Charles J. Campbell,	Rutland,	11.64	3.80	7.84	34.6
		10.58	2.70	7.88	34.2
Joseph Chenelle,	Lowell,	11.00	3.50	7.50	35.2
O. P. Cognos,	Lowell,	10.73	3.10	7.63	35.1
M. J. Collins,	Lynn,	7.82	2.05	5.77	31.5
Thomas W. Cole,	Gloucester,	11.00	3.90	7.10	33.7
		11.05	3.90	7.15	34.1
John M. Cunningham,	Malden,	11.52	3.50	8.02	35.5
		11.52	3.50	8.02	35.4
Herbert E. Daniels,	North Adams,	12.34	4.40	7.94	35.2
George H. Doe,	Milford,	10.50	3.60	6.90	33.5
		9.70	3.30	6.40	32.7
John J. Dwyer,	Sudbury,	10.42	2.70	7.72	35.5
		10.84	3.30	7.54	35.6
		10.92	3.40	7.52	35.5
		10.77	3.20	7.51	35.7

Milk containing Added Water — Continued.

DEALER.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
John J. Dwyer — *Con.*,	Sudbury,	10.92	3.30	7.62	35.8
		10.90	3.20	7.70	35.7
M. Fagan,	Easton,	10.25	2.75	7.50	34.7
		11.61	4.35	7.26	34.2
		10.58	2.80	7.78	36.0
		9.94	2.25	7.69	35.5
Emma A. Forbush,	Braintree,	11.10	3.25	7.85	34.8
		11.18	3.30	7.88	35.3
		12.08	4.00	8.08	35.6
		11.96	3.90	8.06	35.6
		10.28	3.00	7.28	34.6
Edward E. Ford,	Milton,	10.90	3.40	7.50	34.9
		10.40	3.15	7.25	-
		10.90	3.40	7.50	-
		9.66	2.40	7.26	34.4
		10.54	3.00	7.54	-
		10.74	3.25	7.49	-
		10.44	3.10	7.34	-
		9.99	2.70	7.29	-
		10.90	3.35	7.55	-
		10.68	3.10	7.58	-
		10.56	3.00	7.56	-
		10.80	3.35	7.45	-
		10.70	3.20	7.50	-
		10.34	2.80	7.54	-
		9.70	2.40	7.30	34.5
		10.54	3.00	7.54	-
		10.56	3.20	7.36	-
		10.76	3.40	7.36	-
		10.30	3.00	7.30	-
		10.60	3.20	7.40	-
		10.50	3.20	7.30	35.0
Lemuel Friend, Jr.,	Gloucester,	10.60	3.20	7.40	34.4
A. S. Furtado,	Fall River,	10.71	3.50	7.21	33.7
Benjamin Galobaff,	Webster,	12.20	4.20	8.00	35.0

Milk containing Added Water — Continued.

DEALER.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
Benjamin Galobaff — *Con.*,	Webster,	10.24	2.80	7.44	33.2
		11.00	3.70	7.30	33.6
Fred J. Graham,	Lynn,	12.00	4.00	8.00	35.3
P. A. Green,	Milford,	9.46	3.20	6.26	31.8
		6.90	2.20	4.70	27.9
		8.10	2.80	5.30	29.0
Gloucester Dairy Co.,	Gloucester,	10.00	3.10	6.90	33.8
		10.00	3.10	6.90	33.8
		9.20	2.80	6.40	33.0
Geo. H. Hambly,	North Dartmouth,	11.54	3.80	7.74	35.5
Lewis S. Hardy,	Waltham,	12.60	3.10	7.50	34.0
William T. Hardy,	Lexington,	10.12	2.90	7.22	34.3
Stephen Havey,	Hingham,	10.59	3.00	7.59	34.0
		10.20	2.90	7.30	33.3
William O. Jackson,	Hardwick,	11.10	3.60	7.50	34.9
		11.58	3.50	8.08	35.8
		10.58	3.40	7.18	34.0
		10.86	3.20	7.66	35.2
		13.50	5.80	7.70	35.5
		10.74	3.00	7.74	35.2
		11.48	3.70	7.78	35.3
		11.04	3.30	7.74	34.6
Eben B. Kennerson,	Lynn,	10.04	3.05	6.99	33.7
		12.10	4.20	7.90	35.3
		11.24	4.10	7.14	34.1
		10.39	3.35	7.04	33.3
		10.80	4.20	6.60	31.8
Harrison G. Kennard,	- -	8.74	2.40	6.34	31.8
Jacob F. Kirchner,	Dalton,	10.08	3.20	6.88	33.2
Josephine Krug,	Dedham,	10.25	3.20	7.05	34.8
		10.20	3.30	6.90	34.0
		10.80	3.70	7.10	34.0
		10.09	3.10	6.99	34.3
		11.46	3.80	7.66	34.6

Milk containing Added Water — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
Josephine Krug — *Con.*,	Dedham,	12.28	3.90	8.38	35.5
		10.57	3.30	7.27	-
William G. Lane,	West Gloucester,	11.58	3.50	8.08	35.8
		12.00	4.10	7.90	35.7
James A. Lawrence,	Gloucester,	11.30	3.80	7.50	35.9
		7.88	2.20	5.68	31.7
Lecoist Bros.,	Lynn,	10.36	4.10	6.26	31.1
Joseph F. Lecoist,	Lynn,	10.46	3.10	7.36	35.0
		10.40	2.90	7.50	35.0
Thomas Lindsey,	Watertown,	10.86	3.50	7.36	35.4
William C. Mackintosh,	Newburyport,	8.15	0.30	7.85	34.4
William F. Marshall,	West Gloucester,	11.48	3.60	7.88	35.2
Frank S. McCarron,	Lynn,	11.30	3.60	7.70	34.9
Charles Meuse,	East Weymouth,	11.40	4.00	7.40	35.2
		11.46	3.50	7.96	35.9
John Monaghan, Jr.,	Newton,	10.48	3.10	7.38	33.3
		10.30	3.10	7.20	33.4
John C. Moynihan,	Maynard,	11.10	3.20	7.90	35.6
Ralph C. Nickels,	Lowell,	10.67	3.30	7.37	34.5
Chas. J. Nugent,	Rockport,	11.40	3.70	7.70	35.8
Clay M. Nutting,	Pittsfield,	9.86	3.30	6.56	31.8
		9.92	3.10	6.82	32.3
Vener N. Paquette,	Swansea,	10.24	2.75	7.49	34.1
Michael Pendergast,	Great Barrington,	11.90	4.10	7.80	35.8
Frank A. Perry,	Westport,	11.70	4.20	7.50	35.3
		12.60	4.60	8.00	35.8
		11.20	3.25	7.95	34.5
		11.80	3.95	7.85	35.4
Evald Peterson,	Lexington,	11.84	4.20	7.64	35.2
		11.26	3.80	7.46	35.4
		9.80	3.20	6.60	33.2
		12.36	4.30	8.06	35.6
		10.90	3.60	7.30	34.6
		12.36	4.20	8.16	35.7

Milk containing Added Water — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
Gustaf Peterson,	Lexington,	9.33	3.20	6.13	32.5
		8.98	2.60	6.38	32.2
Herbert A. Pomeroy,	Framingham,	11.36	3.30	8.06	35.5
Edwin A. Powers,	Maynard,	6.90	2.10	4.80	29.0
		6.83	2.00	4.83	29.0
		6.80	2.00	4.80	29.0
		6.80	2.00	4.80	29.0
Otto Reiche,	Webster,	10.30	3.15	7.15	34.0
		9.99	2.95	7.04	33.7
Adam Robson,	Salem,	12.38	4.10	8.28	35.0
Frank Sanders,	Tiverton, R. I.,	11.34	4.00	7.34	34.3
William E. Schockly,	Bryantville,	10.57	4.80	5.77	31.0
		11.14	4.30	6.84	32.5
		9.48	3.20	6.28	31.8
Charles M. Schultz,	Norfolk,	10.20	2.90	7.30	34.5
		11.00	3.30	7.70	35.4
Thomas H. Scully,	North Adams,	10.40	2.80	7.60	34.3
John A. Silva,	Fall River,	10.23	3.30	6.93	33.9
		10.77	3.25	7.52	34.3
Manuel F. Simmons,	Swansea,	10.64	3.30	7.34	33.4
		10.80	3.40	7.40	34.4
		10.60	3.50	7.10	34.3
		10.50	3.30	7.20	34.5
		10.60	3.30	7.30	34.2
		10.64	3.60	7.04	34.3
		9.84	3.40	6.44	32.5
		9.63	3.40	6.23	32.3
		9.93	3.40	6.53	32.2
		10.28	3.40	6.88	33.0
Slater & Sons,	Webster,	12.10	4.70	7.40	34.3
Harvey S. Smith,	Pittsfield,	11.00	3.50	7.50	35.4
		11.78	4.25	7.53	35.3
Jacob Spitzer,	North Adams,	12.05	4.80	7.25	33.9
		12.30	4.40	7.90	35.6
		13.10	5.00	8.10	35.4

Milk containing Added Water — Concluded.

DEALER.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
Albin Spyut,	Ipswich,	11.54	3.70	7.84	35.5
Frederick Tracy,	Shirley,	11.10	3.20	7.90	35.1
		11.22	4.00	7.22	33.8
Julia H. Tracy,	Quincy,	10.78	3.10	7.68	35.1
		10.79	3.10	7.69	35.2
Euclid Vallerand,	Lowell,	11.20	3.50	7.70	35.4
		10.50	3.00	7.50	34.6
Jacob Weilock,	Webster,	11.55	3.60	7.95	35.5
J. G. Welch,	Quincy,	11.20	3.40	7.80	35.2
Emma F. Whitney,	Watertown,	11.20	3.80	7.40	35.9
		10.40	3.40	7.00	35.2
John E. Willard,	Fitchburg,	10.75	3.30	7.45	35.3
		11.36	3.50	7.86	35.5
		10.78	3.30	7.48	35.0
		11.08	3.35	7.73	35.5
Morris & Charles Wineapple,	Salem,	9.60	2.85	6.75	30.0

Milk from which a Portion of the Fat had been removed.

DEALER.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Total Proteins (Per Cent.).
George T. Barker,	Wollaston,	8.74	2.40	6.34	2.55
Boston Dairy Company,	Boston,	11.26	2.70	8.56	3.35
		10.46	2.30	8.16	2.99
Edward A. Butlers,	Bedford,	10.80	2.30	8.50	3.38
Charles J. Campbell,	Rutland,	11.47	2.70	8.77	3.11
J. Carvin,	Chelsea,	11.40	2.40	9.00	3.24
M. Carvellas,	Lynn,	11.29	2.30	8.99	3.18
Cloverdale Creamery,	Malden,	11.20	2.50	8.70	3.07
Clarence H. Cutler,	Lexington,	9.24	0.20	9.04	-
Albert Davenport,	Hyde Park,	11.18	2.50	8.68	3.33
Vurtick Demirkiolian,	Bellingham,	11.45	2.30	9.15	3.36

Milk from which a Portion of the Fat had been removed — Concluded.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Total Proteins (Per Cent.).
Wallace Drew,	Lowell,	12.36	3.00	9.36	3.47
Elm Farm Milk Company,	Quincy,	10.67	2.05	8.62	3.11
Charles Fine,	Attleborough,	11.36	2.40	8.96	3.35
A. Gengias,	Lawrence,	11.40	2.60	8.80	3.10
M. Green,	Springfield,	11.83	2.60	8.23	3.44
John C. Haley,	Chelmsford,	11.90	3.05	8.85	3.30
A. Hamaford & Co.,	Waverly,	11.90	2.70	9.20	3.57
M. Moo Hamad,	Worcester,	12.10	2.80	9.30	3.47
Martin Healy,	Springfield,	10.80	2.40	8.40	3.08
W. E. Hetherington,	Peabody,	11.38	2.60	8.78	3.37
H. P. Hood & Sons,	Boston,	9.70	0.10	9.60	-
		9.66	0.10	9.56	-
Zenas A. Jenkins,	East Bridgewater,	10.93	1.60	9.33	3.47
William Johnson,	Quincy,	10.80	2.00	8.80	3.42
Harrison G. Kennard,	Wollaston,	10.84	2.40	8.44	3.35
George Ledingham,	Leominster,	10.76	2.50	8.26	3.00
M. Mabern,	Southbridge,	10.90	2.30	8.60	2.77
John P. Madruga,	Gloucester,	10.56	2.10	8.46	2.91
Hiram Miller,	Milford,	12.28	3.05	9.23	3.54
Ralph C. Nichols,	Lowell,	11.67	2.35	9.32	3.64
George Paiveseley,	Quincy,	10.28	2.10	8.18	2.77
Foster B. Phelps,	Princeton,	11.12	2.50	8.62	2.86
		10.40	2.00	8.40	2.69
		10.60	2.30	8.30	3.08
		10.70	2.20	8.50	2.77
Herbert A. Pope,	Marblehead,	10.02	1.60	8.42	2.93
Geo. Poulin,	Cambridge,	11.38	2.50	8.88	3.28
A. J. Rockwood,	Everett,	11.90	2.70	9.20	3.46
C. Russell,	Lawrence,	11.24	2.45	8.79	3.12
E. J. Sherridan,	Hyde Park,	11.86	2.70	9.16	3.29
Samuel E. Smith,	Springfield,	11.34	2.60	8.74	3.33
D. P. Simpson,	Hyde Park,	11.94	2.90	9.04	3.36
Byron Towne,	Springfield,	11.06	2.60	8.46	3.15
Richard H. Walsh,	Wollaston,	10.84	2.40	8.44	3.35
J. J. Whitaker,	Medford,	10.50	1.80	8.70	-
S. Wesley Young,	Methuen,	12.26	2.65	8.61	3.14

Quality of Milk, by Months.

SAMPLES.	1909.	1910.											
	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	Totals.
Number having more than 15 per cent. total solids.	11	3	3	4	8	7	2	6	13	12	7	9	85
Number having between 14 and 15 per cent. total solids.	38	15	21	32	19	45	24	13	22	27	21	37	314
Number having between 13 and 14 per cent. total solids.	182	109	132	116	90	202	125	57	126	110	166	130	1,545
Number having between 12.15 and 13 per cent. total solids.	181	156	104	219	209	279	222	181	194	348	201	92	2,386
Number having between 11 and 12.15 per cent. total solids.	47	29	26	69	82	58	46	161	96	118	92	35	859
Number having between 10 and 11 per cent. total solids.	10	2	2	4	13	11	7	43	14	13	13	15	147
Number having between 9 and 10 per cent. total solids.	2	7	1	3	2	3	3	7	7	2	3	5	45
Number having between 8 and 9 per cent. total solids.	1	–	–	–	–	1	1	–	1	–	–	1	5
Number having less than 8 per cent. total solids.	–	1	–	4	1	–	1	–	–	1	–	2	10
Number of samples of skimmed milk above standard.	1	3	–	1	2	6	1	1	2	–	2	4	23
Number of samples of skimmed milk below standard.	–	2	1	1	–	4	2	1	2	1	–	3	17
Number of samples of watered milk, .	15	3	3	10	7	5	13	63	14	27	12	20	192
Number of samples above standard, .	413	286	260	372	328	539	374	258	357	497	397	272	4,353
Number of samples below standard, .	59	36	29	79	96	67	57	210	116	134	106	54	1,043
Total samples collected, ...	472	322	289	451	424	606	431	468	473	631	503	326	5,396

It will be seen from the first three tables that the quality of milk obtained from towns is better than that obtained from cities, averaging 12.96 per cent. solids in towns and 12.8 per cent. solids in cities; while the milk obtained from the suspected producers is lower, as would naturally be expected, the average solids of the samples not declared adulterated being 12.63 per cent. Of the total samples collected during the year 80.7 per cent. were above the standard, and if we eliminate the samples obtained from suspected producers and compare the milk from cities and towns as it is sold to the consumer, 83 per cent. of the samples collected were above the standard.

The composition of the milk brought in this year is of a little higher grade than that collected last year, the average for 1909 of the good samples being 12.78 per cent. solids and 4.10 per cent. fat; and the percentage of samples above standard were slightly higher, as in 1909 but 77 per cent. were above the standard. These figures for the past four years are summarized in the following table: —

Comparison of Milk Statistics during Four Years.

YEAR.	ENTIRE COLLECTION.			COLLECTION FROM CITIES AND TOWNS.			AVERAGE OF SAMPLES NOT DECLARED ADULTERATED (PER CENT.).		
	Total Samples.	Above Standard.	Per Cent. above Standard.	Total Samples.	Above Standard.	Per Cent. above Standard.	Solids.	Fat.	Solids not Fat.
1907, . . .	2,992	2,000	66.9	2,602	1,766	67.8	–	–	–
1908, . . .	3,934	2,764	70.4	3,418	2,531	74.1	–	–	–
1909, . . .	4,611	3,584	77.7	3,926	3,174	80.7	12.78	4.01	8.77
1910, . . .	5,396	4,353	80.7	4,817	4,001	83.0	12.85	4.02	8.83

Average of Samples of Milk not declared Adulterated obtained from the Different Counties.

COUNTY.	Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).
Nantucket, ...	13.49	4.74	8.75
Franklin, ...	13.43	4.40	9.03
Berkshire, ...	13.33	4.28	9.05
Dukes, ...	13.24	4.47	8.77
Barnstable, ...	13.12	4.32	8.80
Worcester, ...	13.07	4.20	8.87
Hampden, ...	13.06	4.03	9.03
Bristol, ...	13.02	4.26	8.76
Plymouth, ...	13.00	4.09	8.91
Hampshire, ...	12.82	3.96	8.86
Essex, ...	12.77	4.00	8.77
Middlesex, ...	12.63	3.84	8.79
Suffolk, ...	12.61	3.81	8.80

Quality of Average Milk collected.

	Number of Samples.[1]	Average Solids (Per Cent.).	Average Fat (Per Cent.).	Average Solids not Fat (Per Cent.).	Number of Samples.[2]	Average Solids (Per Cent.).	Average Fat (Per Cent.).	Average Solids not Fat (Per Cent.).
1909.								
December, . .	457	13.09	4.12	8.97	438	13.19	4.16	9.03
1910.								
January, . .	327	12.78	3.89	8.89	314	12.86	3.99	8.87
February, . .	275	13.02	4.05	8.97	266	13.09	4.09	9.00
March, . . .	451	12.76	3.99	8.77	434	12.85	4.05	8.80
April, . . .	424	12.61	3.81	8.80	404	12.69	3.84	8.85
May, . . .	606	12.86	4.01	8.85	588	12.95	4.24	8.71
June, . . .	429	12.79	3.99	8.80	410	12.90	4.03	8.87
July, . . .	472	12.12	3.71	8.41	404	12.39	3.80	8.59
August, . .	463	12.57	3.94	8.63	441	12.68	4.01	8.67
September, . .	579	12.64	3.93	8.71	549	12.74	3.97	8.77
October, . .	499	12.76	3.96	8.83	484	12.82	3.96	8.86
November, . .	305	12.86	4.00	8.86	300	13.16	4.19	8.97

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[1] Total samples collected, exclusive of cream and known purity samples.

[2] Above samples exclusive of samples declared skimmed and watered.

Tables have been made showing the quality of the average milk collected, by months, and the quality of the average samples collected from the different counties.

It will be seen from the table of milk by counties that the milk from the western part of the State is superior to that of the eastern part; and, as would be expected, in those counties where there are a number of large cities, the quality of the milk is lower than in counties with fewer number and smaller cities.

The average quality of milk, by months, is very similar to that of the milk collected a year ago, except that the general average is slightly higher in all months. The lowest quality of milk was found in the month of July, as it was last year.

A larger number of watered samples were found this year than in previous years, but this is owing to there having been more samples collected.

In 1908 but 33 samples, or 3.4 per cent., out of 3,934 collected were declared watered. In 1909, 185, or 4 per cent., out of 4,611 samples collected were declared water, and in 1910, 193 samples, or 3.6 per cent., of 5,396 samples collected were declared watered. It would seem that there is a constant adulteration of milk going on which amounts to about 3.5 per cent. of the market milk, but this figure is undoubtedly too high on account of the large number of samples taken from suspected people.

The Legislature in 1910 passed a bill legalizing the sale of low-standard milk by the producer provided the fat is above the standard. Owing to the fact that our standard is a skimmed milk standard, milk with solids above 11.60 per cent. will, as a rule, be above 3.35 per cent. in fat. This law, then, practically lowers the standard of solids for the producer from 12.15 per cent. to 11.60 per cent., while the retailer who buys this milk cannot sell it without being liable to a fine.

Examples of such milk will be found in the milk obtained from suspected producers in Medfield, Saugus and West Springfield. Such milk can be legally sold in this State by the man who produces it, but it has less food value than some of the milk samples which have been subject to successful prosecutions against the dealer who sold them.

The analyses of several of these samples, together with their food values, are given below: —

Comparison of Low-grade Pure Milk with Adulterated Milk.

	Number of Samples.	Average Solids (Per Cent.).	Average Fat (Per Cent.).	Average Solids not Fat (Per Cent.).	Calories per Gram.
Low-grade milk from Saugus,	17	11.88	3.37	8.51	662.3
Low-grade milk from Medfield,	4	11.73	3.75	7.98	675.9
Low-grade milk from West Springfield,	21	11.95	3.50	8.45	681.9
Watered milk,	1	12.00	4.00	8.00	700.0
Watered milk,	1	12.00	4.30	7.70	715.6
Watered milk,	1	12.24	4.40	7.84	728.6
Skimmed milk,	1	12.26	3.20	9.06	669.1
Skimmed milk,	1	12.40	3.20	9.20	674.8
Skimmed milk,	1	12.60	3.40	9.20	693.4
Average of 42 low-grade samples,	-	11.90	3.46	8.44	668.8
Average of 6 adulterated samples,	-	12.25	3.75	8.50	697.3

The 3 samples of skimmed milk were obtained from a milkman who was fined $50 for the sale of the milk. The 3 samples of watered milk came from 3 different farmers, each of whom paid a $50 fine. If we were to mix these 6 samples of milk we would have a sample of skimmed and watered milk with solids of 12.25 per cent., fat of 3.75 per cent., solids not fat of 8.5 per cent., and a food value of 697.5 calories per gram. This milk, which it is illegal to sell, and which is adulterated to an extent of about 20 per cent., is better milk and has a greater food value than a mixture of the 42 samples of pure milk which it would be legal for the producer to sell, the composition of which would be total solids 11.90 per cent., fat 3.46 per cent., solids not fat 84.4 per cent., with a food value of 668.8 calories per gram.

The breeders of heavy milking cows claim that the milk from such cows is superior to that of Jersey cows, by reason of its low fat content. If a person wishes a milk of low fat content it would be much more economical to purchase two quarts of Jersey milk at 10 cents per quart and one quart of skimmed milk at 2 cents per quart, when by mixing the two and adding 10 per cent. of water, he would obtain 3.3 quarts of milk for 22 cents corresponding in quality to low-grade Holstein milk, which at 9 cents per quart would cost 30 cents.

The detection of added water in milk depends upon being able to show abnormal chemical or physical constants, which can be explained only by the addition of water, there being no test which will distinguish between the water which may be added to the milk and the water naturally present. It is incumbent, therefore, upon persons engaged in the chemical examination of milk to become familiar with the chemical and physical properties of milk of known purity.

A study of the published analyses of milk shows an extreme variance, yet if we study the methods of analysis in connection with the figures a great deal may be explained by incorrectness of the methods then in use. In general, all milk completely drawn from healthy cows will vary between the following limits: —

	Extreme Limits (Per Cent.).	Usual Limits (Per Cent.).	Herd Milk (Per Cent.).
Total solids,	10.0-17.0	10.5-16.0	11.8-15.0
Fat,	2.2- 9.0	2.8- 7.0	3.2- 6.0
Proteins,	2.1- 8.5	2.5- 4.5	2.5- 4.0
Ash,	0.6- 0.9	0.7- 0.8	0.7- 8.0
Solids not fat,	7.5-11.0	7.7-10.0	8.0- 9.5
Milk sugar,	4.0- 6.0	4.2- 5.5	4.3- 5.3

If we depend upon the solids, fat or proteins to indicate added water, it is evident that considerable adulterated milk will escape detection, but if a minimum figure is employed for ash, solids not fat or sugar, more adulterated milk will be discovered. The most successful methods for the detection of added water are based upon the milk sugar content, and for this purpose it is usual to prepare a milk serum, because the most variable constituents (the fat and the proteins) remain in the curd, while the serum will contain the sugar and the ash, which are the least variable. The serum may be prepared by allowing the sample to sour spontaneously,[1] by heating with acetic acid; [2] or calcium chloride; [3] or by treating in the cold with asaprol citric acid solution; [4] or copper sulphate.[5] The copper sulphate method used in the food inspection laboratory of the Massachusetts State Board of Health is as follows: [5] —

Dissolve 72.5 grams of crystallized copper sulphate in water and dilute to 1 liter. This solution should be adjusted, if necessary, so that it will refract at 36 on the scale of the Zeiss immersion refractometer at 20° C., compared with water at 4° C. To one volume of the copper solution add four volumes of sweet milk, shake well and filter. The filtrate will usually be clear after the first few drops have passed through. A determination of the refraction or specific gravity may be made upon the clear serum, and if below the minimum for pure milk the sample may be declared watered.

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[1] Matthes & Muller. Zeit. Offentl. Chem., 10, 173.

[2] Leach & Lythgoe. Jour. Am. Chem. Soc., 26, 1195.

[3] Ackerman. Zeit. Nahr. Genussm, 13, 369.

[4] Baier & Neumann. Zeit. Nahr. Genussm., 13, 369.

[5] Lythgoe. Report Massachusetts State Board of Health, 1908.

If the sample is sour it should be filtered and determinations of refraction, specific gravity or ash made upon the serum.

The examination of 412 samples of milk of known purity from individual cows, 361 being obtained by this department and 51 being examined by the New Jersey State Board of Health, gave the following results.

The samples varied in total solids from 17.17 per cent. to 10.12 per cent.; in fat from 7.7 per cent. to 2.35 per cent.; in solids not fat from 10.65 per cent. to 7.55 per cent.

The refractions of the copper serum were found to be between the following limits: —

Number of Samples.	Refraction.	Number of Samples.	Refraction.
29.	36.0 to 36.4	66,	38.5 to 38.9
32,	36.5 to 36.9	28,	39.0 to 39.4
70,	37.0 to 37.4	12,	39.5 to 40.0
79,	37.5 to 37.9	—	
96,	38.0 to 38.4	412	

The examination of the milk from 28 herds of cows gave the following results: —

Number of Samples.	Refraction.	Number of Samples.	Refraction.
4,	37.1 to 37.4	7,	38.5 to 38.7
12,	37.5 to 37.4	—	
5,	78.0 to 38.4	28	

It is not necessary to possess a refractometer in order to examine milk serum; in fact, it is a waste of money to purchase one if it is to be used for no other purpose, or unless so many samples are to be examined each day that the saving in time would more than offset the price.

The specific refraction of the copper serum $\frac{n^2-1}{n^2+2} \cdot \frac{1}{d}$ is not exactly a constant, decreasing slightly as the refraction grows less, but it is sufficiently uniform for refraction values between 34 and 38, that, if we know the refraction at 20°, we may calculate the specific gravity at 20° compared with water at 4° by the formula —

$$\frac{n^2-1}{n^2+2} \cdot \frac{1}{d_{4}^{20}} = 0.20526.$$

The value of nD corresponding to the scale reading of 36 on the immersion refractometer is 1.34124. Substituting in the above formula we find that $d^{20}_{4} = 1.0245$; therefore, if a refraction, less than 36 indicates added water, the same may be said of a specific gravity less than 1.0245 at 20° C. referred to water at 4° C.

The relation between the refraction and gravity of the serum from spontaneously soured milk is expressed by the formula —

$$\frac{n^2 - 1}{n^2 + 2} \cdot \frac{1}{d^{20}_{4}} = 0.20607.$$

As 38.3 represents the lowest refraction at 20° C., the lowest gravity at $\frac{20^\circ}{4^\circ}$C is 1.0229.

The Influence of Added Water upon the Composition of Milk.

For the purpose of studying the influence of added water upon milk a sample of milk above the average in solids not fat and refraction was obtained, and to this sample water was added in varying amounts. The samples were then analyzed, and the results appear below: —

Composition of a Sample of Milk systematically watered.

Added Water (Per Cent.).	Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	COPPER SERUM.			
				Refraction, 20°.	Specific Gravity, $\frac{20^\circ}{4^\circ}$	$\frac{n^2-1}{n^2+2} \cdot \frac{1}{d}$	Solids (Per Cent.).
0	13.18	4.20	8.98	38.5	1.0272	0.20529	6.09
10	11.86	3.78	8.08	36.4	1.0249	0.20526	5.57
20	10.54	3.36	7.18	34.4	1.0233	0.20523	5.05
30	9.23	2.94	6.29	32.4	1.0211	0.20520	4.56
40	7.91	2.52	5.39	30.6	1.0194	0.20518	4.10
50	6.59	2.10	4.49	28.6	1.0174	0.20516	3.54

A study of the above table shows that each 5 per cent. of added water lowers the refraction by one scale division, and, therefore, in order to detect 10 per cent. of added water in milk the milk before watering must give a serum refracting below 38. The question now arises as to what are the probabilities of this happening. Of 221 samples of known purity milk, 124, or 56 per cent., gave sera refracting below 38, and of these samples, 107, or 48 per cent., were below 12.78 per cent. in total solids, and 114, or 51 per cent., were below 8.77 per cent. in solids not fat. The average of the samples of milk collected by the State Board of Health in 1909, exclusive of samples which could be declared skimmed, watered or cream, was 12.78 per cent. in solids and 8.77 per cent. in solids not fat. It is fair to presume from these figures that the average of the 1909 collection of milk in Massachusetts would refract below 38, and therefore 10 per cent. of water could be detected if it were added to the average milk sold in this State. Probably 40 per cent. of the samples collected would have given sera refracting above 38, and in these cases 15 per cent. of added water could have been detected if the samples had been adulterated to that extent.

The Physical and Chemical Properties of Skimmed Milk, Whole Milk and Cream.

For the purpose of comparing the composition of whole milk, skimmed milk and cream, 2 samples of milk were passed through a separator and analyses were made of the whole milk, skimmed milk and cream. A sample of milk was then watered to an extent of about 20 per cent., the watered milk separated, and analyses were made of the whole milk, watered milk, watered skimmed milk and cream. The results of these analyses are recorded in the following table: —

Analysis of Samples of Milk, Cream and Skimmed Milk.

	Solids (Per Cent.).	Fat (Per Cent.).	Proteins (Per Cent.).	Ash (Per Cent.).	Solids not Fat (Per Cent.).	Sugar (Per Cent.).	Refraction of Copper Serum, 20°.
Sample 1: —							
Cream, ...	41.71	36.20	2.16	0.45	5.51	2.90	37.8
Whole milk, . . .	12.52	3.80	3.22	0.70	8.72	4.80	38.3
Skimmed milk, . .	9.57	0.62	3.48	0.75	8.95	4.85	38.5
Sample 2: —							
Cream, ...	32.84	26.00	2.75	0.54	6.84	3.65	37.8
Whole milk, . . .	12.92	3.90	3.41	0.76	9.02	4.85	37.9
Skimmed milk, . .	9.48	0.30	3.48	0.80	9.18	4.90	37.9
Sample 3: —							
Whole milk, . . .	12.97	3.90	3.38	0.74	9.07	4.95	38.3
Watered cream, . .	35.87	30.00	2.75	0.42	5.87	2.70	34.5
Watered milk, . .	10.48	3.20	2.72	0.61	7.28	3.95	34.4
Watered skimmed milk,	7.67	0.20	2.73	0.59	7 47	4.15	34.4

These figures show that the solids not fat of skimmed milk are, as one would expect, greater than the solids not fat of the whole milk from which it has been separated, and the solids not fat of the cream are less. It also shows that the refraction of the serum of cream and skimmed milk is practically the same as that of the whole milk from which they had been prepared, and that a low refraction of the serum will show added water in cream as well as in milk.

Analyses of Milk of Known Purity.

Breed.	Time since Calving (Mos.).	Weight of Milk (Lbs.).	Specific Gravity, 15°.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteins (Per Cent.).	Ash (Per Cent.).	Solids not Fat (Per Cent.).	Sugar (Per Cent.).	Copper Serum.				Natural Sour Serum.		
										Refraction, 20°.	Specific Gravity, $\frac{20°}{4°}$	Solids (Per Cent.).	Sugar (Per Cent.).	Refraction, 20°.	Specific Gravity $\frac{20°}{4°}$	Ash (Per Cent.).
Grade Durham, . .	2	15	1.035	14.58	5.10	3.35	0.81	9.48	5.00	39.7	1.0280	6.28	4.43	44.4	1.0292	0.768
Holstein, . . .	2	15	1.034	13.65	4.50	3.33	0.72	9.15	4.95	38.4	1.0271	6.05	4.54	43.0	1.0273	0.776
Grade Durham, . .	2	16	1.036	13.52	4.00	3.54	0.72	9.52	5.20	38.9	1.0272	6.09	4.38	43.0	-	-
Grade, ...	1	20	1.033	13.36	4.30	3.25	0.81	9.06	5.00	38.3	1.0270	5.96	4.63	42.0	1.0279	0.816
Grade, ...	4	18	1.034	13.30	4.00	3.54	0.76	9.30	5.00	38.7	1.0269	6.07	4.56	43.1	1.0280	0.830
Holstein, . . .	5	10	1.032	13.29	4.40	3.14	0.70	8.89	4.70	38.8	1.0275	6.10	4.34	42.2	1.0265	0.784
Grade Durham, . .	2	15	1.034	13.27	4.00	3.36	0.78	9.00	5.40	39.2	1.0282	6.20	4.50	43.3	-	-
Grade Ayrshire, . .	1	12	1.033	13.26	4.20	2.84	0.66	9.06	5.50	39.7	1.0281	6.39	4.78	43.9	1.0286	0.750
Grade Swiss, . .	2	16	1.033	13.20	4.35	3.29	0.76	8.85	4.75	37.6	1.0261	5.86	4.48	40.8	1.0259	0.788
Grade Durham, . .	2	15	1.033	13.06	3.80	3.37	0.69	9.26	5.75	38.6	1.0271	6.05	4.82	42.4	1.0274	0.750
Grade Durham, . .	2	16	1.034	13.02	4.10	3.01	0.80	8.92	5.30	39.3	1.0277	6.19	4.47	43.1	1.0286	0.769
Ayrshire, . . .	9	10	1.031	12.91	3.90	3.51	0.76	9.01	4.35	37.3	1.0259	5.73	3.94	41.0	1.0254	0.846
Grade Ayrshire, . .	2	21	1.031	12.85	4.30	3.15	0.68	8.55	5.20	37.1	1.0259	5.66	4.40	39.9	1.0254	0.760
Grade Holstein, . .	2	17	1.032	12.78	4.00	2.89	0.71	8.78	5.05	38.0	1.0274	6.07	4.40	42.1	1.0272	0.768
Grade Holstein, . .	2	18	1.032	12.78	4.00	2.89	0.69	8.78	4.90	38.5	1.0271	6.05	4.40	42.2	1.0269	0.772
Holstein, . . .	6	10	1.031	12.66	3.90	2.97	0.76	8.76	4.35	37.6	1.0268	5.85	4.21	41.8	1.0266	0.820
Grade Holstein, . .	2	20	1.032	12.64	3.80	3.01	0.62	8.84	5.15	38.7	1.0273	6.11	4.71	41.9	1.0270	0.744
Grade Durham, . .	2	18	1.035	12.58	3.70	3.12	0.74	8.88	5.00	38.4	1.0269	5.93	-	41.9	1.0271	0.741
Grade Durham, . .	2	18	1.034	12.54	3.50	2.97	0.68	9.04	5.25	38.8	1.0274	6.06	4.14	42.7	-	-
Grade Durham, . .	2	15	1.033	12.50	3.30	3.08	0.74	9.00	5.05	38.6	1.0271	6.03	4.14	42.7	-	-
Holstein, . . .	4	16	1.031	12.29	3.80	2.65	0.72	8.49	4.85	37.7	1.0266	5.87	4.38	41.8	1.0264	0.755
Holstein, . . .	1	10	1.033	12.27	3.40	3.27	0.84	8.87	4.60	37.6	1.0264	5.82	4.11	41.2	1.0259	0.868
Grade Holstein, . .	8	18	1.032	12.12	3.50	3.32	0.74	8.62	4.40	37.5	1.0258	5.75	4.25	41.4	1.0262	0.780
Grade Ayrshire, . .	3	16	1.032	12.08	3.70	2.80	0.78	8.38	4.65	37.0	1.0259	5.70	4.33	40.6	1.0249	0.804
Grade Holstein, . .	4	20	1.032	12.03	3.45	2.89	0.72	8.58	5.00	38.6	1.0273	6.09	4.43	42.1	1.0270	0.800
Grade Holstein, . .	1	20	1.034	12.00	3.10	2.99	0.71	8.90	5.05	38.4	1.0271	6.07	4.61	41.5	1.0270	0.780
Grade Holstein, . .	4	16	1.030	11.77	3.70	2.67	0.71	8.07	4.50	37.2	1.0261	5.79	4.30	39.7	1.0248	0.740
Holstein, . . .	½	18	1.033	11.40	3.20	2.48	0.72	8.20	5.00	37.5	1.0261	5.75	4.22	41.0	1.0258	0.800
Holstein, . . .	7	15	1.031	11.27	3.15	3.09	0.78	8.12	4.30	36.6	1.0253	5.47	3.73	39.7	1.0244	0.804
Holstein, . . .	10	18	1.031	11.21	3.35	2.81	0.75	7.86	4.30	36.3	1.0250	5.37	3.88	38.7	1.0239	0.792
Holstein, . . .	3	20	1.031	11.48	3.40	2.78	0.80	8.08	4.50	36.8	1.0256	5.53	4.02	40.6	1.0255	0.800
Grade Holstein, . .	4	16	1.030	10.66	2.85	2.66	0.65	7.81	4.40	36.4	1.0254	5.51	4.22	39.1	1.0242	0.740
Holstein, . . .	1	28	1.030	10.20	2.65	2.40	0.65	7.55	4.50	36.5	1.0256	5.45	3.76	38.6	1.0234	0.735
Mixed milk,[1] . . .	-	-	1.033	13.40	4.20	3.13	0.70	9.20	5.10	38.5	1.0269	6.05	4.09	42.2	1.0272	0.780
Mixed milk,[2] . . .	-	-	1.033	13.08	4.10	3.23	0.76	8.98	4.65	37.7	1.0262	5.84	4.34	41.3	1.0259	0.788
Mixed milk,[3] . . .	-	-	1.033	12.73	3.80	3.33	0.71	8.93	4.70	38.0	1.0261	5.94	4.22	41.4	1.0272	0.768
Mixed milk,[4] . . .	-	-	1.032	12.53	3.70	3.35	0.73	8.83	4.75	37.7	1.0259	5.77	4.28	41.5	1.0261	0.808

[1] Grade Ayrshire, Durham, Shorthorn and Holstein cows.

[2] Grade Jersey, Ayrshire and Holstein cows.

[3] Grade Holstein and Grade Jersey cows.

[4] Holstein, Grade Holstein and Grade Jersey cows.

In the accompanying table of analyses of milk of known purity are given the analyses of 37 samples, 4 of herd milk and 33 from individual cows. All these cows were giving a heavy flow of milk, and some of the Holstein cows were being milked three times a day. In all these samples the refraction of the copper serum was above 36 and the per cent. of fat was greater than the proteins. All the work upon known purity milk during the year has confirmed our previous opinion that the presence of added water is shown when the refraction of the copper serum is less than 36, and that when the proteins exceed the fat the sample is skimmed milk.

FOODS EXCLUSIVE OF MILK.

There were 1,640 samples of food exclusive of milk collected, of which 332 were found to be adulterated.

The summary of analyses of these may be found on page 361. Under the several headings, only such foods as require special attention will be discussed.

Breakfast Cereals.

The 2 samples reported adulterated were found to contain vermin. The dealer who made the sale was convicted and fined.

Butter.

One hundred and two samples were examined, of which 18 were adulterated. The adulterated samples consisted of 16 samples of oleomargarine and 2 of renovated butter.

Canned Fish.

The 2 adulterated samples of canned fish were samples of anchovy paste, put out by Harry Peck & Co. of London, and contained a boron preservative.

Canned Fruits and Vegetables.

The single adulterated sample was a sample of condensed tomato soup containing benzoic acid, put up by the Tip-top Ketchup Company of Cincinnati, O.

Cider.

Six of the 26 samples examined contained preservative. In 2 cases both salicylic and benzoic acids were found, and in the other 4 cases the preservative was benzoic acid.

Coffee Extract.

All the samples examined during the year were found free from preservatives.

In testing a sample of coffee extract for benzoic acid by extracting the sample with ether and testing the ether extract in the usual way with ferric chloride, a precipitate was obtained corresponding to the precipitate of ferric benzoate, except in color. Upon subliming this precipitate, the crystals did not have the characteristic appearance of benzoic acid.

The original sample was then subjected to distillation with steam, and the distillate evaporated in alkaline solution, the solution made acid, extracted with ether and the ether extract extracted with ammonia. Upon evaporation of the ammoniacal solution and the addition of ferric chloride a precipitate was obtained which was, as before, dark in color, and on subliming did not give the characteristic crystals of benzoic acid.

A sample of coffee extract was then made from pure coffee, and upon repeating the test on this extract it was found to behave the same as the commercial extract. A large number of extracts were made from different varieties of coffee, and in all cases they reacted in the same manner. This substance which was extracted with ether was found to give precipitates with salts of manganese, nickel, magnesia, calcium, barium, as well as copper and iron, while benzoic acid will give precipitates with only copper and iron salts; and from this the following methods have been devised for the detection of benzoic acid in coffee extract.

Make the sample acid and extract several times with ether; wash the combined ether extract with water and extract with ammonia; evaporate the ammoniacal extract to a small volume and add a solution of manganese sulphate. Filter out the precipitate and wash. Concentrate the filtrate, if necessary adding a few drops of ammonia to prevent the sample from becoming acid, and to this solution add a solution of ferric chloride. In the presence of benzoic acid a dark greenish precipitate will occur. If benzoic acid is absent no precipitate will occur. Evaporate this precipitate to dryness and sublime by placing an inverted funnel in the dish and heating. Some of the sublimed crystals may then be placed in a capillary tube and the melting point taken, which, if the substance is benzoic acid, will be 121.4° C.

The rest of the crystals may be dissolved in ammonia, the excess of ammonia evaporated and ferric chloride added, when the characteristic flesh-colored precipitate will occur if benzoic acid is present.

Cream.

One hundred and four samples were examined during the year, and in no case was any calcium sucrate found. The 6 samples of cream reported adulterated contained less than 15 per cent. of fat.

Cream of Tartar.

Sixteen samples were examined, of which 4 were adulterated. These consisted of the usual mixture of calcium acid phosphate, calcium sulphate and starch.

Dried Fruits.

Fourteen samples were examined, 4 of which contained sulphur dioxide in quantities varying from 0.04 per cent. to 0.20 per cent. Samples found free from sulphites consisted of dried apples, dried olives and dried currants. The sulphites were found in all the samples of dried apricots.

Flavoring Extracts.

Seventy-two samples were examined, 8 of which were reported as adulterated. These consisted of 6 samples of lemon extract, 1 sample of orange extract and 1 of vanilla extract. The following table gives the list of adulterated lemon extracts. The vanilla extract reported as adulterated was a compound vanilla and tonka extract labeled in too small a type. The orange extract contained but a trace of orange oil and bore no brand or name of manufacturer.

List of Adulterated Lemon Extracts.

MANUFACTURER OR BRAND.	Address.	Result of Analysis.
- -	- -	3.7 per cent. lemon oil.
Geo. S. Hull & Co.,	Lowell,	4.4 per cent. lemon oil.
- -	- -	0.29 per cent. lemon oil.
Paris Chemical Company,	Worcester,	0.35 per cent. lemon oil.
The Goodwin Company,	Cambridge,	0.0 per cent. lemon oil.
Coleman Specialty Company,	Boston,	0.0 per cent. lemon oil.

Fruit Juices.

Twenty-one samples were examined, and all but 1 sample were found free from preservatives. This adulterated sample was labeled "West India Lime Juice," put out by Hans Johnson Company, Cienfuegos, West India Islands. It was preserved with salicylic acid and contained 65 per cent. of added water.

Jams and Jellies.

Two samples of the 56 examined were found to be adulterated. These were samples of maraschino cherries. One, from the S. S. Pierce Company, contained 0.02 per cent. sulphur dioxide; the other, a sample of White Swan Maraschino Cherries, put up by the Mahlovitch-Fletcher Company of Cincinnati, O., contained 0.12 per cent. sodium benzoate. The amount of the preservative was not marked in either case.

Lard.

One hundred and forty-seven samples were collected during the year, of which 83 proved to be pure. The other 64 samples were the usual cottonseed oil, and beef or lard stearine mixture.

Malt Liquors.

All the samples of malt liquor examined during the year were found to be free from preservative.

Maple Sugar.

Twenty-seven samples of adulterated maple sugar were obtained during the year from a total of 67 samples collected, the adulterant in all cases being cane sugar. The percentage of cane sugar in the adulterated samples varied from 30 per cent. to 95 per cent.

Maple Syrup.

One sample of adulterated maple syrup was obtained during the year. This sample was labeled "Milford Griddle Cake Syrup." It was largely a cane sugar syrup, containing only 2.6 per cent. of maple syrup.

Meat Products.

Two hundred and eighty-two were examined, of which 85 were reported adulterated. These consisted of 13 samples of hamburg steak, containing sodium sulphites; 71 samples of sausages contained cereal or preservatives, and 1 sample of sausage meat contained cereal.

Olive Oil.

One hundred and forty-eight samples were examined, of which 41 were adulterated, the adulterant in all cases being cottonseed oil, the amount varying from 15 per cent. to 100 per cent.

The Halphen test was found sufficient to detect the adulterant in all cases, and for quantitative purposes the index of refraction was found sufficient. In most cases, as in last year, the majority of the samples were obtained from the Italian or Greek dealers. Some brands of olive oil were found adulterated with cottonseed oil in amounts varying from 0 per cent. to 100 per cent. It was learned that this was due to the peculiarity of the Italians making the mixture. They were said to have added a barrel of olive oil to one of cottonseed oil and then filled the cans without any further mixing of the two oils. This would account for the different percentage of cottonseed oil in the same brand of olive oil.

The following is the list of the adulterated brands of olive oil: —

List of Adulterated Olive Oil.

BRAND.	Manufacturer or Wholesaler.	Result of Analysis.
S. Giovanni Brand,	W. P. Bemagussi, N. Y.,	90 per cent. cottonseed oil.
Olio D'oliva,	R. Antinotti Lucca, Genoa, Italy.	40 per cent. cottonseed oil.
Olio Sopraffino, "Madonna" Brand,	– –	100 per cent. cottonseed oil.
Olio Sopraffino, "Vitili" Brand,	– –	100 per cent. cottonseed oil.
Olio Sapraffino, La Favorita Brand,	– –	20 per cent. cottonseed oil.
Prodotti di olii, Olio Sopraffino,	– –	60 per cent. cottonseed oil.
Elaion Kalamon,	– –	20 per cent. cottonseed oil.
Superfine Olive Oil,	F. Bertolli, Lucca, Tuscany,	35 per cent. cottonseed oil.
Universal Brand Pure,	Frank Conad, N. Y.,	95 per cent. cottonseed oil.
Italian Olive Oil compounded with salad oil.		
Olio Sopraffine per Esportasione,	Albert Branselli & Co.,	20 per cent. cottonseed oil.
Olio Finissimo D'Oliva Vergine R. Ditalia Brand.	– –	80 per cent. cottonseed oil.
Pure Olive Oil, Lucca Mulino Brand,	– –	70 per cent. cottonseed oil.
Sorrento Olive Oil, Savoia Brand,	Santarserio & Telesca,	80 per cent. cottonseed oil.
Olio Puro D'Oliva Garantite Torelli Brand,	– –	100 per cent. cottonseed oil.
Prodotti Italiani Olio D'Oliva Sopraffine,	F. Ferrucci, Lucca, Tuscany,	16 per cent. cottonseed oil.

Pastry.

Twenty-four samples were examined during the year, of which 2 were reported as adulterated. One of these was a sample of pie filling which contained benzoic acid; the other a sample of sweet crackers containing a large number of worms and a large amount of dirt.

Fourteen samples of ice-cream cones were examined, with special reference to the presence of preservatives, and in all cases the samples were found free from preservatives.

Peanuts.

A single sample of peanuts reported adulterated was a sack of peanuts seized at the Brockton Fair. The peanuts were all old and dried up, contained a number of worms and were not fit for human food. The vender was convicted for the sale of decomposed vegetable substance.

Proprietary Foods.

Fifteen samples were examined, of which 5 contained more or less alcohol without the proper labeling.

List of Proprietary Foods containing Alcohol.

Name.	Dealer.	Alcohol (Per Cent.).
Rock Rye and Honey,	Wood, Pollard & Co., Boston,	35.12
Fruit O Brand Lemon, Pineapple, Horehound, Rock and Rye.	New York Pure Food Cordial Company, New York.	19.00
Rees Orange Tonica,	Risley & Co., New York,	22.73
Empire Brand, Apple and Honey,	G. F. Coshland & Co., New York,	37.00
Highland Malt Extract,	Springfield Breweries Company,	6.71

Syrup.

The single adulterated sample was a sample of raspberry cordial put up by N. Mackie-Scott & Co., Leith, Scot., and contained salicylic acid. The other 14 samples were found free from preservative.

Table Sauce.

Twenty-four samples were examined, 1 of which was reported adulterated. This sample was Bishop's Chili Sauce, prepared by Bishop & Co., Los Angeles, San Francisco and New York. It was found to contain 0.52 per cent. of sodium benzoate, and was labeled to contain 0.1 per cent. sodium benzoate.

Vinegar.

One hundred and seventeen samples of vinegar were examined, of which 36 did not conform to the statute requirements. Several of these were wine vinegar, sold by the Italian grocery stores and saloons, the samples not being sufficiently acidified. The per cent. of acid was as low as 2.84 in 1 sample of wine vinegar.

One sample of cider vinegar put out by the Standard Company of Hartford, Conn., was found not to be cider vinegar, and was colored with caramel. A number of samples were obtained of Fleischmann's so-called syrup vinegar. These were found to consist of a distilled vinegar containing molasses or a molasses vinegar as a coloring matter, the amount of distilled vinegar present being estimated at about 80 per cent. The analysis of a sample of this vinegar, together with the analysis of a sample of molasses vinegar made in the laboratory, and dilutions of the same with distilled vinegar, are shown in the accompanying table.

In the examination of the mixtures of molasses and distilled vinegars the phosphates and reducing sugars were calculated, the actual determinations being made in the molasses vinegar only. All the other figures were actually determined.

The increase of color absorption with fuller's earth as the sample is diluted with the distilled vinegar is remarkable. All the color determinations were made with a Dubosque colorimeter, two readings being made, then the tubes reversed to compensate for any variation in the lighting and two more readings taken. These four readings were averaged and color absorbed calculated from the averages.

The same phenomenon was also noticed with another sample of molasses vinegar.

Composition of Mixtures of Molasses Vinegar and Distilled Vinegar.

Molasses Vinegar.	Distilled Vinegar.	Acid.	Solids.	Ash.	Alkalinity of Ash c.c. $\frac{N}{10}$ Acid.	P_2O_5 Total.	P_2O_5 Soluble.	P_2O_5 Insoluble.	REDUCING SUGARS.		Polarisation (Direct).	COLOR ABSORBED BY —	
									Direct.	Invert.		Fuller's Earth.	Lead Acetate.
100	0	5.48	4.59	1.12	48.8	.0426	.0156	.0270	0.86	0.87	+3.0	42	38
75	25	5.36	3.30	0.84	35.7	.0319	.0117	.0203	0.65	0.65	+2.1	54	39
50	50	5.30	2.30	0.56	24.4	.0213	.0078	.0135	0.43	0.43	+1.5	59	58
25	75	5.24	1.20	0.26	11.0	.0106	.0039	.0068	0.21	0.21	+0.7	70	41
15	85	5.20	0.64	0.14	6.0	.0064	.0023	.0041	0.12	0.12	+0.5	72	45
0	100	5.10	-	-	-	-	-	-	-	-	-	-	-

Wine.

Thirty-eight samples were examined, 10 of which were reported adulterated by reason of the presence of sulphur dioxide. The type of the wine together with the amount of sulphur dioxide found are reported in the following table. Samples of claret, angelica, port and sherry were found free from sulphur dioxide, although in most cases sulphates were present, which was undoubtedly due to the sulphuring of the barrel.

Sulphur Dioxide in Wine.

TYPE OF WINE.	Sulphur Dioxide (Per Cent.).	TYPE OF WINE.	Sulphur Dioxide (Per Cent.).
Angelica,	0.008	Muscat,	0.003
Claret,	0.001 to 0.018	Port,	0.001
Chianti,	0.004	Riesling,	0.006
Hockheimer,	0.010 to 0.015	Sauterne,	0.007 to 0.026
Miscellaneous,	0.003 to 0.012	Tokay,	0.003 to 0.012

Summary of Statistics of Food exclusive of Milk.

	Genuine.	Adulterated.	Total.		Genuine.	Adulterated.	Total.
Baking powder,	5	–	5	Gluten flour,	4	–	4
Breakfast cereal,	–	2	2	Honey,	23	–	23
Butter,	84	18	102	Horseradish,	7	–	7
Canned fish,	21	2	23	Hulled corn,	1	–	1
Canned fruit and vegetables,	23	1	24	Jams and jellies,	54	2	56
Cheese,	15	–	15	Lard,	83	64	147
Cider,	20	6	26	Malt liquors: —			
Clams,	2	–	2	Ale,	7	–	7
Clam bouillon,	1	–	1	Beer,	5	–	5
Cocoa,	29	–	29	Malt extract,	3	–	3
Coffee,	14	–	14	Porter,	1	–	1
Coffee extract,	1	–	1	Maple sugar,	40	27	67
Condensed milk,	19	4	23	Maple syrup,	15	1	16
Confectionery,	17	–	17	Meat products: —			
Cornstarch,	1	–	1	Beef steak,	1	–	1
Cream,	98	6	104	Canned meats,	8	–	8
Cream of tartar,	12	4	16	Hamburg steak,	27	13	40
Dried fruits,	10	4	14	Head cheese,	2	–	2
Flavoring extracts: —				Lambs' tongues,	2	–	2
Banana,	1	–	1	Mince meat,	15	–	15
Cinnamon,	1	–	1	Pigs' feet,	1	–	1
Ginger,	2	–	2	Poultry,	1	–	1
Lemon,	21	6	27	Pressed meat,	5	–	5
Maple,	1	–	1	Sausages,	127	71	198
Nutmeg,	1	–	1	Sausage meat,	1	1	2
Orange,	1	1	2	Tongue cheese,	1	–	1
Peppermint,	4	–	4	Tripe,	6	–	6
Raspberry,	1	–	1	Molasses,	2	–	2
Vanilla,	29	1	30	Non-alcoholic drinks,	7	–	7
Wintergreen,	2	–	2	Olive oil,	107	41	148
Fruit juices: —				Oysters,	2	–	2
Grape,	13	–	13	Pastry,	22	2	24
Lemon,	1	–	1	Peanuts,	–	1	1
Lime,	3	1	4	Peanut butter,	16	–	16
Orange,	1	–	1	Pickles,	24	–	24
Pineapple,	2	–	2	Potato salad,	1	–	1

Summary of Statistics of Food exclusive of Milk — Concluded.

	Genuine.	Adulterated.	Totals.		Genuine.	Adulterated.	Totals.
Proprietary foods,	10	5	15	Sugar,	6	–	6
Rye meat,	1	–	1	Syrup,	14	1	15
Salad dressing,	4	–	4	Table sauce,	23	1	24
Salad oil,	1	–	1	Vinegar,	81	36	117
Shrimp,	2	–	2	Wine,	28	10	38
Smoked fish,	1	–	1	Totals,	1,308	332	1,640
Spices,	60	–	60				

DRUGS.

During the year 769 samples of drugs have been examined. Of these, 617 were reported as pure and 152 as adulterated. The character and quality of these are shown in the table on page 372. Only such drugs as need special comment will be discussed.

Alcohol.

Seventy-eight samples of alcohol were collected, 70 of which conformed to the pharmacopœial requirements. Seven of the adulterated samples were so reported on account of their being low in alcohol; the percentage of alcohol varied from 72 per cent. to 87 per cent. One sample was found to be denatured alcohol.

Chlorinated Lime.

The adulterated sample collected was branded chloride of lime, Philadelphia Lye and Chemical Company, and contained but 26 per cent. of available chlorine. The pharmacopœial requirement is 30 per cent. available chlorine.

Cocaine Hydrochloride.

The 9 samples reported adulterated were pure cocaine hydrochloride, but were illegally sold.

Fluid Extract of Ginger.

Two samples were examined, 1 of which did not conform to the pharmacopœial requirements. This sample was water soluble extract of ginger used for flavoring and not the medicinal extract.

Gin.

Ten samples were examined, 2 of which were low in alcohol. These contained 37.97 per cent. and 40.9 per cent. alcohol, respectively.

Camphor Liniment.

Forty-nine samples were examined, 10 of which were low in camphor. The following list gives the name of the druggist and the percentage of camphor in the sample in 5 cases. The other 5 samples were not according to the United States Pharmacopœia, but the variation from the standard was so slight that the names of the dealers are not published. United States Pharmacopœia camphor liniment should contain 20 per cent. camphor.

List of Adulterated Samples of Camphor Liniment.

NAME ON LABEL.	Address.	Result of Analysis.
Markell Drug Company,	Boston and Chelsea,	15 per cent. camphor.
Choate Drug and Chemical Company,	Boston,	13 per cent. camphor.
R. G. Coffin & Co.,	Nantucket,	4 per cent. camphor.
Oak Bluffs Drug Store,	Oak Bluffs,	4 per cent. camphor.
A. W. Cunningham,	Springfield,	15 per cent. camphor.

Lithium Citrate.

Two samples of lithium citrate tablets were examined, both of which were found to be of the quality represented on the labels.

Methyl Alcohol.

Six samples were examined, 3 of which, classed as adulterated, were sold without being properly labeled.

Morphine Pills.

The single sample of morphine pills reported as adulterated was sold without a physician's prescription.

Oils.

Samples of linseed, cod liver, olive, castor and turpentine oils were examined, and in all cases were found to be pure.

Pepsin.

Nine samples were examined, 5 of which were found to be considerably deficient in digesting properties.

Proprietary Medicines.

Fifty-five samples were examined, 43 of which conformed to the law. The following table gives the name and result of the analysis of the adulterated samples: —

List of Adulterated Proprietary Medicines.

NAME.	Manufacturer or Wholesaler.	Result of Analysis.
Coke Dandruff Cure and Hair Tonic,	A. R. Brenner Company, New York and Chicago.	30 per cent. wood alcohol.
Vino de Quina y Cacao,	Dr. Castillo, Gutierrez Hermanos Jorez.	18.03 per cent. alcohol.
Fairbanks Rock Cordial,	E. L. Monroe Company, Boston,	24 per cent. alcohol.
Sun Cholerine Mixture,	Walker Rintels Company, Boston,	68.32 per cent. alcohol.
Dr. Carpenter's Equalizing Drops,	- -	60.1 per cent. alcohol.
Clayton & Russell's Standard Wild Cherry Cordial.	Adams & Co., New York,	18.88 per cent. alcohol.
Sun Cholera Mixture,	Markell-Weston Drug Company, Chelsea.	19.28 per cent. alcohol.
Cholera Mixture,	Morris, Druggist, Boston,	56.40 per cent. alcohol.
Az-Ma-Syde,	- -	Cocaine.
Az-Ma-Syde Tablets,	- -	Acetanilid.
Boks Cold Tablets,	Pierce Drug Company, Boston,	Acetanilid.
Kefaline Headache Cure,	Kefaline Company,	Acetanilid.

Spirit of Anise.

One hundred and twenty-two samples of spirit of anise were examined, 81 of which contained 10 per cent. of anise oil. The other 41 samples were low in anise oil.

The anise oil was assayed as follows: —

Place 10 cubic centimeters of spirit of anise in a Babcock fat bottle, add 20 cubic centimeters of saturated salt solution, shake thoroughly, fill the bottle with salt solution and shake again, add salt solution to fill the neck and whirl in the centrifuge for about ten minutes. From the oil reading the per cent. of oil is obtained by comparing with the following table, compiled from investigations made, by Mr. C. E. Marsh of this department: —

Per Cent. of Anise Oil.

Scale of Bottle.	Tenths of Scale of Bottle.									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0.	–	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3
1.	2.5	2.7	2.9	3.1	3.3	3.5	3.7	4.0	4.2	4.4
2.	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2	6.4
3.	6.6	6.8	7.0	7.2	7.4	7.6	7.9	8.1	8.3	8.5
4.	8.7	8.9	9.1	9.3	9.5	9.7	10.0	10.2	10.4	10.6
5.	10.8	11.0	11.2	11.4	11.6	11.8	12.0	12.2	12.4	12.6

The index of refraction may be used to corroborate the amount of oil found by the centrifugal method. It was found that in order to dissolve any appreciable amount of anise oil in alcohol the alcohol must be stronger than 80 per cent., and from this fact the strength of the alcohol used is assumed at 95 per cent. in the following table compiled by Mr. Marsh. If the per cent. of oil found by the refraction method is materially different from that found by the centrifugal method, it is due to the use of wood alcohol, weak alcohol, oils other than anise or to other substances in solution, and the further examination should be made.

Anise Oil (Per Cent.).	Anise Oil (Per Cent.).									
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	nD 25°									
0.	1.3635	1.3636	1.3638	1.3639	1.3641	1.3643	1.3645	1.3647	1.3648	1.3650
1.	52	54	56	58	59	61	63	65	66	68
2,	70	72	74	75	77	79	81	83	85	86
3,	88	90	92	94	96	97	99	701	703	704
4,	706	708	710	712	714	715	717	19	21	23
5,	25	27	29	30	32	34	36	38	39	41
6,	43	45	46	48	50	52	54	55	57	59
7,	61	63	64	66	68	70	71	73	75	77
8,	79	80	82	84	86	88	89	91	93	95
9,	96	98	800	802	804	805	807	809	811	813
10,	814	816	18	20	21	23	25	27	29	30

The presence of oil of fennel would be shown upon polarization. United States Pharmacopœia spirit of anise should polarize at 0.0, its index of refraction at 25° should be 1.3814, and its specific gravity at 15°, 0.8546.

It was claimed in a contested case that the action of light on spirit of anise would reduce the amount of oil in the sample. To determine this point a sample of spirit of anise was prepared and was divided in two portions, one bottle being kept in the sun, the other being kept in the dark. The determination of the index of refraction and of the oil separated in the Babcock bottle have been made at intervals during nine months, and the figures obtained in all of the tests have been found to be within the experimental error, there being absolutely no change in the amount of oil in the sample. The index of refraction of this sample was 1.3816 at 20°, and the calculated amount of oil present was 10.3 per cent.

One sample of spirit of anise was allowed to stand in an open bottle. and it was found that the percentage of oil increased in the sample, due to the evaporation of the alcohol. The following table gives the per cent. of oil in this sample during the experiment: —

Spirit of Anise left in Open Bottle.

After 0 days, reading of bottle was 4.8, corresponding to 10.4 per cent. oil.
After 4 days, reading of bottle was 4.9, corresponding to 10.6 per cent. oil.
After 10 days, reading of bottle was 5.2, corresponding to 11.2 per cent. oil.
After 34 days, reading of bottle was 6.6, corresponding to 13.8 per cent. oil.
After 42 days, reading of bottle was 7.5, corresponding to 15.0 per cent. oil.
After 50 days, reading of bottle was 8.7, corresponding to 17.4 per cent. oil.
After 72 days, reading of bottle was 50.0,[1] corresponding to 100.0 per cent. oil.

From the experiments above described it is evident that if spirit of anise below standard is sold by a druggist it became so because he did not put in enough anise oil. Several druggists claimed that they added sufficient oil, and therefore the oil must have been adulterated. A few submitted the anise oil, and in all cases the oil was pure. The only adulterant that could possibly be in anise oil in order that a tincture made from the same would contain less than 10 per cent. of oil is alcohol, and undoubtedly all commercial anise oils are free from this. The druggist could easily ascertain the per cent. of alcohol by adding some water to a sample of the oil and shaking. If the oil was adulterated with alcohol the water would dissolve in the alcohol and the oil would separate. By measuring the amounts of oil and water before, and of oil and alcohol after shaking, the amount of alcohol and oil in the sample may be approximately determined.

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[1] 1 cubic centimeter taken, reading of 5.0 multiplied by 10 = 50.0.

Complaints have been made by druggists about collecting samples of spirit of anise because of its insignificance, but as this is a substance that probably all druggists make upon their premises, it shows the care they use in preparing the drugs and prescriptions manufactured on the premises, and such preparations show the accuracy of the druggist in compounding. The druggist is supposed to be an intelligent man, and it seems that an intelligent man should be able to measure one volume of anise oil and dilute it with sufficient alcohol to make ten volumes. A man who cannot do this within an error of 10 per cent. is unfit to put up a prescription.

The following gives the list of druggists selling spirit of anise below 80 per cent. of the United States pharmacopœial strength: —

List of Adulterated Samples of Spirit of Anise.

DEALER.	Address.	Result of Analysis.
C. R. Hilberg & Co.,	Brockton and Campello,	2.5 per cent. anise oil.
Bixby Drug Store,	Brockton,	3.5 per cent. anise oil.
M. B. Crowell & Co.,	Brockton,	5.9 per cent. anise oil.
Blake's Pharmacy,	Brockton,	6.3 per cent. anise oil.
Charles C. Hearn,	Quincy,	6.3 per cent. anise oil.
J. W. Patch & Co.,	Boston,	6.0 per cent. anise oil.
Frank J. McGarry,	Boston,	2.1 per cent. anise oil.
Deehan Drug Company,	Boston,	4.6 per cent. anise oil.
A. B. Kelly,	Lawrence,	3.4 per cent. anise oil.
Walter J. Keating,	Lawrence,	1.5 per cent. anise oil.
Hall & Lyon Company,	Lowell,	5.4 per cent. anise oil.
Frank E. McNabb,	Lowell,	4.5 per cent. anise oil.
Parmenter Pharmacy,	Boston,	7.5 per cent. anise oil.
T. H. Farrell,	Pittsfield,	5.6 per cent. anise oil.
Fahey's Pharmacy,	Pittsfield,	6.3 per cent. anise oil.
A. W. Davis & Co.,	Lowell,	5.8 per cent. anise oil.
Concord Drug Company,	Lowell,	4.8 per cent. anise oil.
East Merrimac Drug Company,	Lowell,	4.2 per cent. anise oil.
Chicopee Drug Company,	Chicopee,	4.9 per cent. anise oil.
Charles W. King,	Chicopee,	5.6 per cent. anise oil.

Spirit of Nitrous Ether.

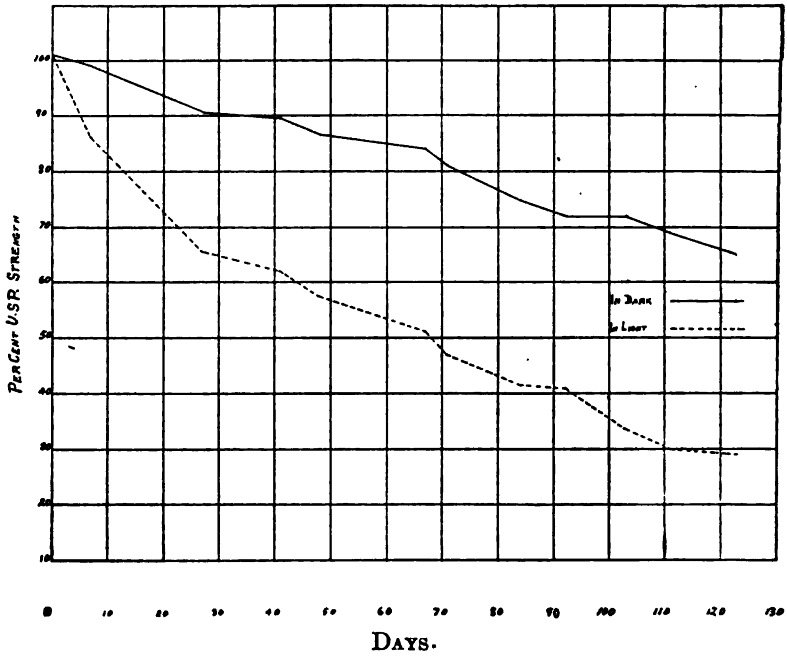
Fifteen samples were examined, 5 of which were found to be up to strength; the other 10 were from 41 per cent. to 71 per cent. of the United States pharmacopœial requirements.

In order to determine the rate of decomposition of spirit of nitrous ether a sample was made up according to the pharmacopœial requirements and divided into two portions, one of which was kept in the dark in an amber-colored bottle, and one was kept in the light, and these samples were assayed from time to time during four months. It was found that the sample kept in the light decomposed very rapidly, the percentage of United States pharmacopœial strength becoming reduced from 101 to 29 in four months, while a sample kept in the dark remained over 80 per cent. of the required strength for two months, and was above 70 per cent. of the required strength after three months.

It would seem from these figures as though druggists should be able to keep their spirit of nitrous ether up to at least 80 per cent. of the pharmacopœial requirement by keeping the bottle in the dark, and making up a new lot every three months.

The following chart shows the rate of decomposition found of these two samples of ether: —

Rate of Decomposition of Spirit of Nitrous Ether.



Spirit of Camphor.

Forty-six samples were examined, 9 of which were low in camphor. The worst one contained but 50 per cent. of the required amount of camphor; the others were between 80 per cent. and 90 per cent. of the United States pharmacopœial requirements. The samples were tested for wood alcohol with negative results.

Whiskey.

Eleven samples were examined, 6 of which were below the pharmacopœial requirements in alcohol. The lowest sample contained 36 per cent. alcohol by volume. All the samples were examined for wood alcohol, with negative results.

Spirit of Peppermint.

Seventy samples were collected and 14 were found to contain less than 10 per cent. of peppermint oil, 6 of which contained from 8 per cent. to 9 per cent. The following table gives the list of dealers selling this drug below 80 per cent. of the United States pharmacopœial strength, and the results of the analyses of the samples. From three of these stores 2 poor samples were obtained, and the lowest sample is reported in each case.

List of Adulterated Samples of Spirit of Peppermint.

DRUGGIST.	Address.	Result of Analysis.
Wm. L. Davis, ...	Worcester, ...	6.11 per cent. peppermint oil.
N. R. Scott, ...	Worcester, ...	6.00 per cent. peppermint oil.
Castle Square Drug Company, .	Boston, ...	6.30 per cent. peppermint oil.
Geo. H. Hartwell, ... :	Southbridge, ...	4.60 per cent. peppermint oil.
W. A. DeMerrit, ...	Boston, ...	5.30 per cent. peppermint oil.

Precipitated Sulphur.

Thirty samples were examined, of which 13 were adulterated. These samples all contained calcium sulphate in amounts varying from 11.91 per cent. to 62.25 per cent.

Tincture of Iodine.

Nine of the 123 samples examined were below the pharmacopœial requirements. Two of these samples were obtained from the Markell Drug Company, Boston, and were 50 per cent. and 75 per cent. of the

United States pharmacopœial strength. One sample of 71 per cent. strength was purchased from Ira B. Case, Prides Crossing, and the other 6 poor samples were between 80 per cent. and 90 per cent. of the United States pharmacopœial strength.

Tincture of Ginger.

The 10 samples examined were found to conform to the pharmacopœial requirements.

As a considerable portion of ginger is soluble in cold water, a number of samples of tincture of ginger were made up with varying amounts of ginger, alcohol and water, for the purpose of studying the influence of the water-soluble portion of the ginger upon the physical constants and chemical compositions of the different tinctures. This work was carried on by Mr. L. I. Nurenberg.

Ten samples of tincture of ginger were made up as follows: —

Tincture A. — According to the requirements of the Pharmacopœia.

Tincture B. — The United States pharmacopœial amount of ginger was used, but the sample was exhausted with 73 per cent. alcohol.

Tincture C. — The full amount of ginger and 49 per cent. alcohol.

Tincture D. — The full amount of ginger and 30 per cent. alcohol.

Tincture E. — Half quantity of ginger with 95 per cent. alcohol.

Tincture F. — With exhausted ginger from tincture B, with 94 per cent. alcohol.

Tincture G. — Two per cent. oleoresin of ginger and 95 per cent. alcohol.

Tincture H. — Two per cent. oleoresin of ginger and 75 per cent. alcohol.

Tincture I. — Two per cent. oleoresin of ginger and 50 per cent. alcohol.

Tincture J. — Two per cent. oleoresin of ginger and 25 per cent. alcohol.

These 3 latter tinctures were made by weighing the oleoresin into a flask and adding the necessary amount of 95 per cent. alcohol. Water was then added to the mark, the mixture was treated with magnesia and filtered.

Determinations were made of specific gravity, index of refraction, percentage of alcohol, refraction of alcoholic distillate, total solids, alcohol-soluble solids and water-soluble solids.

The analyses of these are shown in the accompanying table, together with the analyses of 6 commercial samples: —

Tincture of Ginger.

SAMPLE.	Specific Gravity, $\frac{20^\circ}{4^\circ}$	nD 20°	REFRACTION OF ALCOHOLIC DISTILLATE.		ALCOHOL (PER CENT.).		SOLIDS (PER CENT.).		
			Found.	Calculated.	Weight.	Volume.	Total.	Alcohol Soluble.	Water Soluble.
A. . . .	0.8184	1.3662	47.8	47.5	85.38	89.76	1.40	1.33	0.24
B. . . .	0.8863	1.3664	39.2	38.7	61.46	69.08	2.08	1.33	1.04
C. . .	0.9462	1.3609	29.6	29.5	36.66	43.68	2.89	1.13	2.40
D. . . .	0.9794	1.3518	22.1	22.1	19.13	23.44	3.11	0.30	2.96
E. . . .	0.8156	1.3645	48.1	47.9	87.82	91.64	0.70	0.67	0.21
F. . . .	0.8352	1.3650	46.1	46.1	82.32	87.36	0.18	0.18	0.06
G. . . .	0.8144	1.3668	49.0	47.9	87.14	91.12	1.24	1.16	0.10
H. . . .	0.8807	1.3658	40.3	38.9	65.06	72.44	1.05	0.86	0.51
I. . . .	0.9398	1.3593	30.5	29.7	38.23	45.40	1.03	0.50	0.79
J. . . .	0.9762	1.3484	22.4	21.9	19.33	23.68	0.95	0.18	0.92
1. . . .	0.8229	1.3667	48.0	46.6	83.29	88.12	1.50	1.47	0.24
2. . . .	0.8555	1.3678	44.3	43.1	73.65	80.12	2.33	2.02	0.49
3. . . .	0.8491	1.3674	44.8	43.7	75.42	81.64	1.61	1.40	0.57
4. . . .	0.9054	1.3645	36.8	35.8	53.46	61.32	1.42	0.67	1.12
5. . . .	0.9321	1.3596	31.7	30.9	40.95	48.36	0.64	0.56	0.45
6. . . .	0.8436	1.3688	45.9	44.8	78.56	84.28	2.74	2.36	0.71

It will be noticed from these results that as the percentage of alcohol is decreased, the amount of ginger being constant, the per cent. of solids in the tinctures is increased. This is due to the presence of the water-soluble ginger solids, as it will be seen that the alcoholic-soluble solids decrease with the decreased per cent. of alcohol, while the water-soluble solids increase. The sample made with half the amount of ginger shows about half the solids that the tincture made with the full amount of ginger shows.

Of the commercial samples, Nos. 1, 2, 3 and 6 agree in composition very closely with the United States pharmacopœial preparation. No. 4 appears to be made from exhausted ginger with weak alcohol, and No. 5 is probably made from oleoresin of ginger and weak alcohol.

Mercurial Ointment.

The 2 samples reported adulterated contained 40.32 per cent. and 31.7 per cent. of mercury, respectively. The full strength mercurial ointment should contain 50 per cent. mercury.

Zinc Oxide Ointment.

Two samples were reported adulterated; these contained 23 per cent. and 18 per cent. of the required amount of zinc oxide.

Summary of Statistics of Drugs.

	Genuine.	Adulterated.	Total.		Genuine.	Adulterated.	Total.
Alcohol,	70	8	78	Pulvis glycyrrhizæ comp.,	1	–	1
Aqua hamamelidis,	20	–	20	Quinine pills,	2	–	2
Calx chlorinata,	1	1	2	Saccharum lactis,	1	–	1
Cologne,	1	–	1	Sodii bicarbonas,	5	–	5
Cocainæ hydrochloras,	–	3	3	Sodii boras,	10	–	10
Essence of pepsin,	1	–	1	Sodii phosphas,	2	–	2
Fluidextractum zingiberis,	1	1	2	Spiritus anisi,	81	41	122
Gin,	8	2	10	Spiritus ætheris nitrosi,	5	10	15
Glycerinum,	4	–	4	Spiritus camphoræ,	37	9	46
Linimentum camphoræ,	39	10	49	Spiritus frumenti,	5	6	11
Linimentum chloroformi,	2	–	2	Spiritus menthæ piperitæ,	56	14	70
Lithium citrate tablets,	2	–	2	Spiritus myrciæ,	1	–	1
Lycopodium,	1	–	1	Spiritus vini gallici,	1	–	1
Magnesii sulphas,	1	–	1	Sulphur iodidum,	2	–	2
Methyl alcohol,	3	3	6	Sulphur præcipitatum,	17	13	30
Morphine pills,	–	1	1	Sulphur sublimatum,	4	–	4
Oleum lini,	1	–	1	Tinctura iodi,	114	9	123
Oleum morrhuæ,	1	–	1	Tinctura zingiberis,	10	–	10
Oleum olivæ,	14	–	14	Unguentum aquæ rosæ,	1	–	1
Oleum ricini,	3	–	3	Unguentum hydrargyri,	1	2	3
Oleum terebinthinæ,	6	–	6	Unguentum zinci oxidi,	35	2	37
Pepsinum,	4	5	9	Total,	617	152	769
Proprietary medicines,	43	12	55				

INSPECTION OF LIQUORS.

The police department of 28 cities and towns sent in during the year 108 samples of liquor for examination, of which 92 contained more than 1 per cent. of alcohol. The following table gives the number and character of the samples obtained from the different localities: —

Summary of Liquor Statistics.

Locality.	Beer.	Cider.	Wine.	Whiskey.	Miscellaneous.	Total.
Attleborough,	-	2	-	-	- -	2
Barre,	-	2	-	-	- -	2
Boston,	-	-	4	1	- -	5
Brockton,	-	-	-	-	2, unknown,	2
Chatham,	-	2	-	-	- -	2
Fall River,	18	1	-	-	- -	19
Franklin,	1	-	-	1	- -	2
Gloucester,	3	-	-	-	- -	3
Hingham,	2	-	-	-	- -	2
Hudson,	-	-	-	-	4, sink mixtures; 1, gin,	5
Hyde Park,	-	-	-	-	2, Jamaica ginger,	2
Lowell,	-	-	-	-	1, alcohol,	1
Lynn,	-	-	3	-	1, coffee; 1, liquor; 1, water,	6
Melrose,	-	3	-	1	- -	4
Mendon,	4	-	-	-	- -	4
Middleborough,	-	1	-	-	- -	1
New Bedford,	-	-	1	-	- -	1
Newton,	-	1	3	2	- -	6
Norwood,	-	-	-	-	1, Jamaica ginger,	1
Quincy,	-	-	-	-	2, syrups,	2
Randolph,	-	1	-	-	- -	1
Revere,	1	-	10	-	- -	11
Saugus,	-	-	1	-	- -	1
Somerville,	-	2	-	1	- -	3
Wakefield,	-	1	-	-	2, unknown,	3
Wareham,	1	-	-	-	3, malt extract; 1, beef, iron and wine,	5
Watertown,	-	-	10	-	- -	10
Winchester,	-	2	-	-	- -	2
Totals,	30	18	32	6	22	108

Two samples of liquor of unknown designation came from Wakefield and contained 23 per cent. and 30 per cent. alcohol, respectively.

The 2 samples of "unknown liquor" from Boston contained 19 per cent. and 20 per cent. of alcohol, respectively.

The sample of coffee from Lynn contained 4 per cent. alcohol; the sample of water, 1 per cent. alcohol, and the sample marked "liquor" contained 49 per cent. alcohol.

The samples obtained from sink drains in Hudson contained 7.32 per cent. alcohol, 3.21 per cent. alcohol, 6.02 per cent. alcohol and 7.32 per cent. alcohol. A sample of gin from the same town contained 42 per cent. alcohol.

A sample of Jamaica ginger submitted by the police department of Norwood contained 30.13 per cent. of alcohol. Two samples were submitted by the Quincy police. These were red and blue syrups free from alcohol obtained from a Syrian. The police had reason to believe that this syrup was being sold for intoxicating purposes.

A sample of beef, iron and wine obtained from Wareham contained 20 per cent. of alcohol. The samples of malt extract from the same place contained 5.94 per cent., 5.76 per cent. and 6.02 per cent. of alcohol. The defendants were convicted in the cases resulting from these last four analyses.

The attendance of the analyst has been required in the Lower Courts at Boston, Gloucester, Hingham, Hudson, Lynn, Newton, Quincy and Wareham; and in the superior courts in Plymouth and Middlesex counties.

EXAMINATION OF POISONS.

The Legislature of 1910 passed the following act: —

ACTS OF 1910, CHAPTER 495.

AN ACT TO REQUIRE THE STATE BOARD OF HEALTH TO MAKE ANALYSES OF DRUGS AND POISONS IN CERTAIN CASES.

Be it enacted, etc., as follows: —

SECTION 1. The state board shall make, free of charge, a chemical analysis of cocaine, alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salt or compound thereof, and of any poison, drug, medicine or chemical, when submitted to it by police authorities or by such incorporated charitable organizations in the commonwealth as the state board of health shall approve for this purpose: *provided*, that said board is satisfied that the analysis is to be used for the enforcement of law.

SECTION 2. The said board shall furnish a certificate of the result of the analysis above provided for to said authorities or organizations, and the certificate shall be prima facie evidence of the composition and quality of the materials so analyzed.

SECTION 3. This act shall take effect upon its passage. [*Approved May 7, 1910.*

As a result of this law, between June 11 and November 30, 23 samples have been submitted to the department for analysis; of this number, 15 were sent in by the Watch and Ward Society, 6 by the Boston Police Department, 1 by the Lowell Police Department, and 1 by the Leominster Police Department.

Fourteen samples were cocaine hydrochloride, either purchased or seized, 2 samples were gum opium, both purchased, and 4 samples were morphine tablets. One of these samples of morphine tablets was passed to a prisoner in Suffolk County in a newspaper, another was sent to a prisoner in some tobacco, and the other 2 samples were found upon prisoners in Suffolk County.

A sample of sedlitz powder was sent in by the Lowell Police Department. This sedlitz powder was obtained from a druggist from whom a similar sample was alleged to have been obtained which was said to have caused the death of a child. The sample submitted was free from poison and conformed to the United States pharmacopœial requirements.

A liquid submitted by the Boston Police Department was obtained from a woman prisoner. From the information obtained from the police department this woman seemed to have a desire to dispose of her husband by putting this solution in his food. The mixture proved to be a saturated solution of boric acid in water.

A sample of milk said to have caused sickness was sent in from Leominster. This sample was found to contain considerable arsenic.

The attendance of the analyst has been required in court in Boston and Roxbury.

General Summary.

	Legal.	Illegal.	Total.
Milk,	4,353	1,043	5,396
Foods, exclusive of milk,	1,308	332	1,640
Drugs,	617	152	769
Liquor,	16	92	108
Poisons,	2	21	23
Totals,	6,296	1,640	7,936

Respectfully submitted,

HERMANN C. LYTHGOE.

INSPECTION OF DAIRIES.

By the Secretary of the Board.

INSPECTION OF DAIRIES.

During the year ended Nov. 30, 1910, 2,053 dairies were examined by the Board's veterinarian, and the attention of 737 proprietors and of boards of health of cities and towns, wherein the dairies were situated or the product thereof sold, was called to a total of 2,515 objectionable conditions. As in previous years, suggestions were made regarding changes considered necessary in the interest of a wholesome supply and of the public health.

Of the total number of dairies examined, 1,983 were situated in Massachusetts and 70 in neighboring States. The extra-state dairies were visited because of the fact that their product is marketed in this Commonwealth, and, if found to be other than the fresh, clean product of healthy cows, is, under the standards fixed in accordance with the provisions of the national law relative to food and drugs, to be deemed to be adulterated, and hence may not enter into interstate commerce.

The following table shows the number of dairies examined in the cities and towns visited, and the percentage found in each place to be commendable: —

Inspection of Dairies, 1910.

CITY OR TOWN.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Abington,	-	-	-	-
Second inspection,	27	5	22	81.48
Alford,	12	8	4	33.33
Amesbury,	9	4	5	55.56
Second inspection,	18	6	12	66.67
Andover,	18	7	11	61.11
Second inspection,	12	3	9	75.00
Ashburnham,	5	3	2	40.00
Second inspection,	9	3	6	66.67
Ashland,	10	2	8	80.00
Second inspection,	7	1	6	85.71
Third inspection,	1	-	1	100.00

Inspection of Dairies, 1910 — Continued.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Athol,	7	2	5	71.43
Second inspection,	9	3	6	66.67
Berlin,	3	2	1	33.33
Second inspection,	24	6	18	75.00
Third inspection,	2	-	2	100.00
Bolton,	6	3	3	50.00
Second inspection,	34	9	25	73.53
Braintree,	3	2	1	33.33
Second inspection,	14	6	8	57.14
Bridgewater,	-	-	-	-
Second inspection,	13	4	9	69.23
Canton,	-	-	-	-
Second inspection,	20	7	13	65.00
Dedham,	3	3	-	-
Second inspection,	24	13	11	45.83
East Bridgewater,	1	1	-	-
Second inspection,	31	3	28	90.32
Egremont,	16	13	3	18.75
Georgetown,	2	-	2	100.00
Second inspection,	7	-	7	100.00
Grafton,	10	4	6	60.00
Second inspection,	26	9	17	65.38
Third inspection,	3	2	1	33.33
Great Barrington,	36	21	15	41.67
Halifax,	-	-	-	-
Second inspection,	11	2	9	81.82
Hanover,	1	-	1	100.00
Second inspection,	12	4	8	66.67
Hanson,	9	1	8	88.89
Second inspection,	1	-	1	100.00
Haverhill,	15	6	9	60.00
Second inspection,	77	10	67	87.01
Hingham,	-	-	-	-
Second inspection,	9	3	6	66.67
Third inspection,	1	-	1	100.00

Inspection of Dairies, 1910 — Continued.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Holbrook,	-	-	-	-
Second inspection,	10	2	8	80.00
Holliston,	4	1	3	75.00
Second inspection,	24	6	18	75.00
Third inspection,	4	1	3	75.00
Hopkinton,	2	1	1	50.00
Second inspection,	29	10	19	65.52
Hyde Park,	10	8	2	20.00
Second inspection,	2	1	1	50.00
Kingston,	3	1	2	66.67
Second inspection,	18	4	14	77.78
Leominster,	-	-	-	-
Second inspection,	50	13	37	74.00
Littleton,	3	-	3	100.00
Second inspection,	2	-	2	100.00
Third inspection,	48	10	38	79.17
Fourth inspection,	6	1	5	83.33
Marshfield,	4	-	4	100.00
Second inspection,	7	1	6	85.71
Medfield,	35	22	13	37.14
Merrimac,	-	-	-	-
Second inspection,	14	8	6	42.86
Methuen,	1	1	-	-
Second inspection,	75	29	46	61.33
Third inspection,	1	-	1	100.00
Middleborough,	10	4	6	60.00
Second inspection,	22	6	16	72.73
Milford,	21	8	13	61.90
Second inspection,	7	2	5	71.43
Millis,	13	8	5	38.46
Second inspection,	17	8	9	52.94
Milton,	1	-	1	100.00
Second inspection,	20	5	15	75.00
Natick,	5	-	5	100.00
Second inspection,	14	4	10	71.43

Inspection of Dairies, 1910 — Continued.

CITY OR TOWN.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Needham,	8	4	4	50.00
Second inspection,	11	4	7	63.64
Third inspection,	1	-	1	100.00
New Braintree,	3	2	1	33.33
Second inspection,	32	11	21	65.63
Newbury,	6	4	2	33.33
Second inspection,	28	13	15	53.57
Newburyport,	5	3	2	40.00
Second inspection,	19	12	7	36.84
Newton,	11	2	9	81.82
Second inspection,	43	13	30	69.77
North Andover,	3	-	3	100.00
Second inspection,	21	4	17	80.95
Northborough,	8	2	6	75.00
Second inspection,	49	11	38	77.55
Third inspection,	3	3	-	-
Norwell,	2	2	-	-
Second inspection,	13	1	12	92.31
Norwood,	22	11	11	50.00
Petersham,	20	8	12	60.00
Plymouth,	13	8	5	38.46
Second inspection,	33	14	19	57.58
Plympton,	-	-	-	-
Second inspection,	9	-	9	100.00
Quincy,	18	9	9	50.00
Second inspection,	19	8	11	57.89
Randolph,	1	-	1	100.00
Second inspection,	14	3	11	78.57
Rockland,	1	1	-	-
Second inspection,	11	5	6	54.55
Rowley,	1	-	1	100.00
Second inspection,	22	11	11	50.00
Rutland,	-	-	-	-
Second inspection,	12	1	11	91.67
Salisbury,	3	-	3	100.00
Second inspection,	22	9	13	59.09

Inspection of Dairies, 1910 — Continued.

CITY OR TOWN.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Scituate,	5	1	4	80.00
Second inspection,	7	1	6	85.71
Third inspection,	2	1	1	50.00
Sherborn,	4	1	3	75.00
Second inspection,	16	5	11	68.75
Third inspection,	1	-	1	100.00
Southborough,	4	1	3	75.00
Second inspection,	35	9	26	74.29
Fifth inspection,	1	1	-	-
Sterling,	10	7	3	30.00
Second inspection,	80	53	27	33.75
Third inspection,	1	-	1	100.00
Sudbury,	-	-	-	-
Second inspection,	1	1	-	-
Third inspection,	7	2	5	71.43
Fourth inspection,	4	-	4	100.00
Templeton,	1	-	1	100.00
Second inspection,	12	3	9	75.00
Wellesley,	9	2	7	77.78
Westborough,	18	6	12	66.67
Second inspection,	58	22	36	62.07
West Bridgewater,	1	-	1	100.00
Second inspection,	28	5	23	82.14
West Newbury,	1	1	-	-
Second inspection,	39	16	23	58.97
Weymouth,	2	1	1	50.00
Second inspection,	15	5	10	66.67
Whitman,	-	-	-	-
Second inspection,	11	1	10	90.91
Winchendon,	8	3	5	62.50
Second inspection,	11	2	9	81.82
Winchester,	2	-	2	100.00
Second inspection,	11	4	7	63.64
Third inspection,	1	-	1	100.00
Miscellaneous,	50	21	29	58.00
Fitzwilliam, N. H.,	1	1	-	-

Inspection of Dairies, 1910 — Concluded.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Pelham, N. H.,	-	-	-	-
Second inspection,	1	-	1	100.00
Walpole, N. H.,	7	7	-	-
Westmoreland, N. H.,	5	5	-	-
Buskirks, N. Y.,	-	-	-	-
Second inspection,	14	5	9	64.29
Cambridge, N. Y.,	-	-	-	-
Second inspection,	13	4	9	69.23
Eagle Bridge, N. Y.,	-	-	-	-
Second inspection,	16	7	9	56.25
Hoosick, N. Y.,	-	-	-	-
Second inspection,	4	3	1	25.00
Petersburg, N. Y.,	-	-	-	-
Second inspection,	2	-	2	100.00
Schaghticoke, N. Y.,	-	-	-	-
Second inspection,	7	5	2	28.57
Outside dairies,	70	37	33	47.14
Total Massachusetts dairies,	1,983	700	1,283	64.70
Total dairies,	2,053	737	1,316	64.10

Under "Miscellaneous" are included dairies situated in the following places, in no one of which were more than 8 inspected, the examinations having been made for some special reason, and not as a part of a general investigation: —

Billerica.
Boylston.
Carver.
Dracut.
Duxbury.
Groveland.
Hardwick.
Harvard.
Hudson.
Medway.
Mendon.
Millbury.
Monterey.
Pembroke.
Royalston.
Sheffield.
Stoneham.

In addition to the foregoing, 815 dairies were visited at which the sale of milk had been discontinued.

NATURE OF THE DEFECTS TO WHICH ATTENTION WAS CALLED.

Below is presented an analysis of the 2,515 objectionable conditions to which the attention of boards of health was called: —

	Defects.	
CONDITION OF COWS.		
Herd with anthrax,	1	
Unclean herds,	168	
		169
CONDITION OF BARNS.		
Dairies unfit for milk production,	19	
Tie-up floor in need of repairing,	3	
Tie-up ceiling in need of repairing,	1	
		23
Light.		
Insufficient number of windows,	47	
Windows inadequate in size,	26	
		73
Ventilation.		
Additional ventilation needed,	1	
Barn overcrowded,	6	
		7
General Cleanliness.		
General uncleanliness of premises,	371	
Tie-up in need of cleaning and whitewashing,	601	
Accumulated manure,	10	
Manure piled back of cows,	7	
Sand used as bedding for cows,	1	
Horse manure used as bedding for cows,	6	
Loam used as bedding for cows,	1	
Cobwebs,	212	
Privy in barn,	10	
Slaughtering in barn,	1	
Lack of proper drainage,	1	
Unclean cellar,	6	
Horses not separated from cows,	19	
Pigs kept near cows,	35	
Swill kept near cows,	7	
Brewers' grains in vicinity of cows,	1	
Poultry in cow tie-up,	1	
Decomposing vegetables in cow tie-up,	1	
Cow tie-up used for general storage,	1	
Cows kept in barn cellar,	3	
		1,295

CONDITION OF COW YARDS.

	Defects.	
Yard in need of proper drainage,	99	
General uncleanliness,	96	
Manure in yard,	8	
Swill in yard,	4	
Carcasses of animals in yard,	1	
		208

WATER SUPPLIES.

Well exposed to surface drainage,	8	
		8

MILK ROOMS.

Milk room needed,	119	
Unclean milk room,	47	
Milk room unused,	9	
Milk room used for general storage,	6	
Milk room located between two piles of manure,	1	
Milk room located in barn,	2	
Milk room floor in need of repair,	3	
Milk room in need of a new floor,	1	
		188

CARE OF MILK AND MILK UTENSILS.

Milk cooled: —		
(*a*) On barn floor,	19	
(*b*) In barn cellar,	1	
(*c*) In unclean shed,	5	
(*d*) In grain room,	3	
(*e*) In well,	3	
(*f*) In watering trough,	16	
(*g*) In barn-yard,	12	
		59
Milk handled: —		
(*a*) On barn floor,	256	
(*b*) In barn-yard,	8	
(*c*) In cow tie-up,	7	
(*d*) In grain room,	3	
(*e*) In horse stall next to horses,	1	
(*f*) In dirty shed,	4	
(*g*) In barn cellar,	1	
(*h*) In wagon shed,	1	
		281

		Defects.	
Milk stored: —			
(*a*) On barn floor,	13		
(*b*) In barn cellar,	1		
(*c*) In unclean shed,	5		
(*d*) In grain room,	3		
(*e*) In house kitchen,	1		
(*f*) In yard,	2		
(*g*) In watering trough on side of road,	1		
(*h*) In well,	3		
		29	
Unclean water in cooling trough,		4	
Separator kept in barn,		3	
Cooler kept in barn shed,		1	
Cans kept in barn,		163	
Cans aired on a fence over manure pile,		1	
Unclean milk utensils,		3	
			544
Total number of objectionable features,			2,515

EXAMINATION OF PLUMBERS.

EXAMINATION OF PLUMBERS.

EXAMINATION OF PLUMBERS.

State Board of Health, Commonwealth of Massachusetts, State House, Boston, Mass.

GENTLEMEN: — The State Examiners of Plumbers, as required in section 3, chapter 536, Acts of 1909, respectfully submit the following statement of their affairs for the year ending Nov. 30, 1910: —

EXAMINATIONS.	Examined.	Passed.	Refused.
Boston, Dec. 4, 1909,	34	12	22
Lowell, Dec. 18, 1909,	10	-	10
Boston, Jan. 1, 1910,	32	8	24
Pittsfield, Jan. 15, 1910,	9	4	5
Boston, Feb. 5, 1910,	48	14	34
Springfield, Feb. 19, 1910,	32	15	17
Boston, March 5, 1910,	61	20	41
Fall River, March 19, 1910,	25	8	17
Boston, April 2, 1910,	57	18	39
Worcester, April 16, 1910,	24	14	10
Boston, May 7, 1910,	71	35	36
Lowell, May 21, 1910,	32	11	21
Boston, June 4, 1910,	80	27	53
Pittsfield, June 18, 1910,	28	8	20
Boston, July 2, 1910,	67	15	52
Boston, Sept. 3, 1910,	77	23	54
Springfield, Sept. 17, 1910,	44	15	29
Boston, Oct. 1, 1910,	45	10	35
Fall River, Oct. 15, 1910,	31	6	25
Boston, Nov. 5, 1910,	59	13	46
Worcester, Nov. 19, 1910,	21	13	8
Totals,	887	289	598

	Masters.	Journeymen.	Total.
Licenses granted on account of examination, December, 1909, to December, 1910,	74	215	289
Probationary licenses issued during the year,	-	-	15

REGISTRATIONS.	Masters.	Journeymen.
December, 1909,	227	426
January, 1910,	332	658
February, 1910,	18	38
March, 1910,	38	68
May, 1910,	929	1,788
June, 1910,	85	146
July, 1910,	49	95
August, 1910,	60	129
September, 1910,	50	126
October, 1910,	19	46
November, 1910,	10	32
Totals,	1,817	3,552

Meetings,	81	Examinations,	21

FEES RECEIVED.	Paid to Treasurer of the Commonwealth.
887 examination fees, at $0.50,	$443 50
1,817 masters' licenses, at $2,	3,634 00
3,552 journeymen's licenses, at $0.50,	1,776 00
806 masters' renewals, at $0.50,	403 00
1,597 journeymen's renewals, at $0.50,	798 50
Total,	$7,055 00

Salary, clerk,	$2,000 00
Wages, second and third examiners,	700 00
Traveling expenses,	517 14
Express charges,	29 66
Printing,	512 40
Postage,	420 87
Books and stationery,	85 28
Plumbing materials,	30 25
Cleaning,	21 25
Extra services,	623 68
Advertising,	55 20
Miscellaneous,	5 64
Total,	$5,001 37

In connection with the above statement we feel it our duty at this time to call to your attention the fact that although this Board has received in fees an amount in excess of expenditures for this year, it will have a deficit for coming and future years if present conditions prevail, inasmuch as the initial fee for master plumber is $2, but when renewed only 50 cents. The examiners believe the Board should be self-supporting, and if approved by you would recommend that the fees be fixed by the State Examiners of Plumbers from time to time, subject to the approval of the State Board of Health.

The examiners, upon assuming office and in taking over the registrations of plumbers from the various cities and towns, found a preferred class of plumbers called certificate holders, that is, those persons who were registered as being engaged in the plumbing business prior to July 10, 1893, who in some cities and towns were not required to register or renew their license each year, as was required of a plumber who was licensed after examination. In several cities all plumbers were required to renew each year, regardless of how they were originally registered, and fees were collected from all registered plumbers. The examiners, being required to furnish a correct list of plumbers from time to time to the cities and towns, believe that all plumbers on that list should register each year, and pay a fee for same.

The examiners would direct your attention to the fact that many plumbers who have been engaged in the plumbing business in sparsely settled portions. of the Commonwealth, as yet without any plumbing regulations, while not being required to qualify in their home town, see their business horizon continually narrowing as new territories accept regulations. Some of these plumbers are of advanced age, and an examination would be embarrassing, if not prohibitive.

The examiners believe provision should be made for registering, without examination, those plumbers who have been in the plumbing business prior to July 10, 1893, and continuously since that time, when vouched for by the board of health of the town where said plumber is located.

If the above recommendations are concurred in by your Board the examiners believe the attention of the proper authorities should be invoked for legislation necessary to put same into effect.

Respectfully submitted,

JAMES C. COFFEY.
CHAS. R. FELTON.
EDWARD C. KELLY.

REPORT

UPON THE

PRODUCTION AND DISTRIBUTION OF DIPHTHERIA ANTITOXIN AND VACCINE VIRUS

FOR THE

YEAR ENDED NOV. 30, 1910.

REPORT

UPON THE

PRODUCTION AND DISTRIBUTION OF DIPHTHERIA ANTITOXIN AND VACCINE VIRUS

FOR THE

YEAR ENDED NOV. 30, 1910.

The production of diphtheria antitoxin and vaccine has continued under the direction of Dr. Theobald Smith, at the laboratory of the State Board of Health at Forest Hills. The distribution has been conducted, as before, at the office of the Board.

The total number of packages issued by the Board during the fifteen years and eight months ended Nov. 30, 1910, was as follows: —

	Bottles.
In 1895–1896 (year ended March 31),	1,724
In 1896–1897 (year ended March 31),	3,219
In 1897–1898 (year ended March 31),	4,668
In 1898–1899 (year ended March 31),	12,491
In 1899–1900 (year ended March 31),	31,997
In 1900–1901 (year ended March 31),	53,389
In 1901–1902 (year ended March 31),	40,211
In 1902–1903 (year ended March 31),	33,475
In 1903–1904 (year ended March 31),	41,133
During six months ended Sept. 30, 1904,	22,255
In 1904–1905 (year ended Sept. 30, 1905),	47,387
During fourteen months ended Nov. 30, 1906,	70,424
In 1906–1907 (year ended Nov. 30, 1907),	64,807
In 1907–1908 (year ended Nov. 30, 1908),	94,645
In 1908–1909 (year ended Nov. 30, 1909),	90,131
In 1909–1910 (year ended Nov. 30, 1910),	92,623
Total,	704,579

The serum was distributed to local boards of health, to hospitals and to practitioners in 208 cities and towns, 61 of which used more than 100 bottles each. The following table shows the distribution: —

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1909, to Nov. 30, 1910.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Abington,	48	Braintree,	58
Acton,	12	Bridgewater,	24
Adams,	167	Brockton,	348
Agawam,	11	Brookline,	147
Amesbury,	133	Buckland,	6
Amherst,	6	Cambridge,	987
Andover,	160	Hospital for Contagious Diseases,	790
Arlington,	134	Hospital,	70
Ashburnham,	62	Canton,	244
Athol,	72	Massachusetts Hospital for Crippled and Deformed Children.	18
Attleborough,	95	Chelsea,	296
Ayer,	196	Chesterfield,	6
Barnstable,	18	Chicopee,	148
Barre,	6	Clinton,	160
Bedford,	8	Colrain,	6
Belchertown,	6	Concord,	12
Belmont,	49	Cummington,	6
Berkley,	6	Dalton,	12
Berlin,	12	Danvers,	328
Beverly,	152	State Hospital,	865
Blackstone,	97	Dedham,	139
Boston: —		Dennis,	12
Boston Lying-in Hospital,	40	Dighton,	24
Carney Hospital,	50	Douglas,	6
Children's Hospital,	1,963	Dover,	25
City Hospital,	38,772	Dudley,	18
General supply,	9,580	Duxbury,	12
Infants' Hospital,	130	East Bridgewater,	14
Massachusetts Charitable Eye and Ear Infirmary.	36	Easthampton,	18
Massachusetts General Hospital,	75	Easton,	24
Massachusetts Homœopathic Hospital.	1,570	Erving,	12
Massachusetts Infant Asylum,	25	Essex,	6
Parental School,	90	Everett,	276
Perkins Institution and Massachusetts School for the Blind.	38	Fairhaven,	36
St. Mary's Infant Asylum,	461	Fall River,	922
Training ship "Ranger,"	37	Falmouth,	24
Bourne,	12	Fitchburg,	1,148

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1909, to Nov. 30, 1910 — Continued.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Foxborough,	100	Littleton,	12
Framingham,	84	Lowell,	987
Franklin,	18	Ludlow,	36
Gardner,	72	Lynn,	1,230
Georgetown,	6	Hospital for Contagious Diseases,	2,023
Gloucester,	297	Malden,	622
Grafton,	46	Mansfield,	60
Granby,	4	Marblehead,	47
Great Barrington,	6	Children's Island Sanatorium,	87
Greenfield,	18	Marion,	6
Hadley,	9	Marlborough,	72
Hamilton,	6	Marshfield,	6
Hanover,	18	Mattapoisett,	12
Hanson,	12	Maynard,	18
Hardwick,	23	Medfield,	64
Harvard,	12	State Asylum,	90
Harwich,	6	Medford,	250
Hatfield,	12	Medway,	12
Haverhill,	1,333	Melrose,	291
Hingham,	29	Merrimac,	35
Hinsdale,	19	Methuen,	18
Holbrook,	12	Middleborough,	96
Holliston,	12	Middleton,	6
Holyoke,	670	Milford,	196
Hopedale,	24	Millbury,	18
Hubbardston,	4	Millis,	6
Hudson,	12	Milton,	48
Hull,	76	Monson,	48
Huntington,	71	Montague,	12
Hyde Park,	260	Nantucket,	12
Ipswich,	35	Natick,	60
Kingston,	36	Needham,	42
Lawrence,	1,827	New Bedford,	997
Leicester,	12	Newbury,	4
Lenox,	6	Newburyport,	300
Leominster,	348	Newton,	200
Lexington,	111	Hospital,	443

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1909, to November 30, 1910 — Continued.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
North Adams,	48	Somerville,	1,633
North Andover,	11	Hospital for Contagious Diseases,	1,797
North Attleborough,	24	Southborough,	6
North Brookfield,	12	Southbridge,	37
North Reading,	23	Spencer,	24
Northampton,	85	Springfield,	2,114
Northbridge,	60	Stoneham,	112
Northfield,	18	Stoughton,	48
Norton,	17	Stow,	12
Norwell,	6	Sunderland,	6
Norwood,	198	Sutton,	24
Orange,	62	Swampscott,	24
Oxford,	6	Taunton,	246
Palmer,	107	Templeton,	6
Peabody,	72	Tewksbury,	106
Pepperell,	6	Topsfield,	11
Petersham,	23	Townsend,	10
Pittsfield,	520	Truro,	12
Plymouth,	274	Uxbridge,	22
Provincetown,	72	Wakefield,	124
Quincy,	372	Walpole,	46
Randolph,	6	Waltham,	468
Reading,	77	Hospital,	1,485
Revere,	123	Ware,	137
Rockland,	47	Wareham,	6
Rockport,	18	Warren,	12
Rowley,	12	Watertown,	82
Russell,	12	Webster,	133
Salem,	407	Wellesley,	61
Salisbury,	12	West Boylston,	12
Saugus,	195	West Bridgewater,	10
Scituate,	18	West Brookfield,	6
Sharon,	83	West Springfield,	196
Sheffield,	6	Westborough,	18
Shelburne,	24	Lyman School for Boys,	12
Shirley,	12	Westfield,	144
State Industrial School for Boys,	35	Westford,	6

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1909, to Nov. 30, 1910 — Concluded.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Westminster, ...	6	Winchester, ...	42
Westport, ...	48	Winthrop, ...	158
Weymouth, ...	353	Woburn, ...	208
Whitman, ...	143	Worcester, ...	3,587
Williamsburg, ...	6	Wrentham, ...	2
Williamstown, ...	12	Total, ...	92,623
Wilmington, ...	59		

The total number of tubes of vaccine virus issued by the Board during the six years and two months ended Nov. 30, 1910, was as follows: —

	Tubes.
In 1904–1905 (year ended Sept. 30, 1905), ...	23,970
During fourteen months ended Nov. 30, 1906, ...	31,805
In 1906–1907 (year ended Nov. 30, 1907), ...	45,265
In 1907–1908 (year ended Nov. 30, 1908), ...	48,768
In 1908–1909 (year ended Nov. 30, 1909), ...	47,961
In 1909–1910 (year ended Nov. 30, 1910), ...	76,690
Total, ...	274,459

The vaccine virus was distributed as shown in the following table: —

Number of Tubes of Vaccine distributed from Dec. 1, 1909, to Nov. 30, 1910.

City or Town.	Number of Tubes.	City or Town.	Number of Tubes.
Abington, ...	83	Beverly, ...	65
Amesbury, ...	621	Boston: —	
Andover, ...	90	Children's Hospital, . . .	25
Arlington, ...	414	City Hospital, ...	1,620
Ashby, ...	12	General supply, ...	17,635
Attleborough, ...	494	Infants' Hospital, ...	210
Ayer, ...	89	Massachusetts General Hospital, .	148
Bedford, ...	43	Penal institutions, ...	1,800
Belmont: —		Perkins Institution and Massachusetts School for the Blind.	50
Massachusetts School for the Feeble-minded.	895	St. Elizabeth's Hospital, . . .	102
McLean Hospital, ...	50	St. Mary's Infant Asylum, . .	200

Number of Tubes of Vaccine distributed from Dec. 1, 1909, to Nov. 30, 1910 — Continued.

CITY OR TOWN.	Number of Tubes.	CITY OR TOWN.	Number of Tubes.
Braintree,	195	Hudson,	25
Bridgewater,	422	Hull,	50
Brimfield,	25	Hyde Park,	295
Brockton,	842	Kingston,	15
Brookline,	860	Lawrence,	4,230
Cambridge,	1,864	Lee,	65
Canton,	26	Leicester,	40
Chelmsford,	135	Lexington,	139
Chelsea,	1,346	Lincoln,	23
Chesterfield,	20	Lowell,	1,850
Chicopee,	264	Ludlow,	28
Clinton,	500	Lynn,	2,948
Cohasset,	130	Malden,	590
Concord,	79	Mansfield,	68
Massachusetts Reformatory,	800	Marblehead,	217
Cummington,	35	Marshfield,	22
Danvers,	398	Medfield,	44
Insane Hospital,	165	Medford,	164
Dedham,	539	Medway,	90
Duxbury,	39	Melrose,	445
East Bridgewater,	163	Merrimac,	45
Easton,	648	Methuen,	165
Everett,	269	Milford,	150
Fairhaven,	41	Millbury,	215
Fall River,	5,500	Milton,	95
Falmouth,	10	Monson,	20
Fitchburg,	795	State Hospital,	50
Foxborough,	202	Needham,	210
Freetown,	50	Newburyport,	6
Georgetown,	30	Newton,	720
Gloucester,	258	Hospital,	30
Great Barrington,	75	North Adams,	410
Groton,	26	North Andover,	50
Hamilton,	63	North Brookfield,	500
Hingham,	193	North Reading,	30
Holbrook,	77	State Sanatorium,	35
Holden,	55	Northfield,	3

Number of Tubes of Vaccine distributed from Dec. 1, 1909, to Nov. 30, 1910 — Concluded.

CITY OR TOWN.	Number of Tubes.	CITY OR TOWN.	Number of Tubes.
Norwood,	244	Waltham,	525
Orange,	40	Ware,	110
Oxford,	30	Wareham,	5
Palmer,	245	Warren,	25
Peabody,	200	Watertown,	163
Pembroke,	43	Wayland,	25
Pittsfield,	56	Webster,	35
Plymouth,	96	Wellesley,	325
Provincetown,	12	West Brookfield,	258
Quincy,	553	West Newbury,	41
Randolph,	70	West Springfield,	20
Reading,	1,440	Westborough: —	
Revere,	415	State Hospital,	225
Rockland,	160	Westfield,	270
Salem,	326	Westford,	116
Scituate,	31	Westminster,	75
Sharon,	25	Westport,	72
Sherborn,	10	Weymouth,	264
Shirley,	20	Whitman,	27
Somerville,	1,075	Williamstown,	125
Southborough,	100	Wilmington,	155
Springfield,	1,691	Winchendon,	675
Stoneham,	1,260	Winchester,	195
Stoughton,	70	Winthrop,	61
Swampscott,	505	Woburn,	220
Taunton,	1,145	Worcester,	2,100
Tewksbury: —		Memorial Hospital,	75
State Hospital,	1,655	Wrentham: —	
Townsend,	49	State School,	370
Wakefield,	2,572	Yarmouth,	3
Walpole,	125	Total,	76,690

REPORT

UPON THE

WORK OF THE BACTERIOLOGICAL LABORATORY

FOR THE

YEAR ENDED NOV. 30, 1910.

REPORT UPON DIPHTHERIA CULTURES EXAMINED DURING THE YEAR ENDED NOV. 30, 1910.

From Dec. 1, 1909, to Nov. 30, 1910, 3,531 cultures were received from 165 cities and towns in the State. Of these cultures, 1,955 were for the purpose of diagnosis and 1,576 were for release from quarantine.

The following table gives the number of cultures received from the different cities and towns and the results of the examinations: —

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Abington,	6	1	3	2
Adams,	11	4	4	3
Amesbury,	73	9	14	50
Andover,	21	2	10	9
Arlington,	29	3	13	13
Ashburnham,	17	1	6	10
Ashland,	4	-	3	1
Athol,	63	17	20	26
Attleborough,	55	9	24	22
Ayer,	37	2	1	34
Barnstable,	6	2	-	4
Bedford,	1	-	-	1
Belmont,	15	1	8	6
Beverly,	86	21	27	38
Blackstone,	1	1	-	-
Boston,	3	1	2	-
Bourne,	1	-	-	1
Boxborough,	1	-	1	-
Braintree,	21	1	19	1
Bridgewater,	3	1	1	1
Burlington,	1	-	1	-
Canton,	39	3	7	29
Carver,	2	1	1	-

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Charlemont,	2	-	2	-
Chelsea,	137	16	31	90
Cheshire,	3	-	3	-
Cohasset,	5	-	5	-
Colrain,	1	1	-	-
Concord,	14	1	7	6
Conway,	1	-	1	-
Danvers,	47	4	20	23
Dedham,	67	10	21	36
Douglas,	3	-	-	3
Dover,	2	-	2	-
Duxbury,	15	3	2	10
Easton,	3	-	-	3
Everett,	173	34	51	88
Fairhaven,	4	2	-	2
Falmouth,	3	1	1	1
Foxborough,	52	9	30	13
Framingham,	43	17	5	21
Franklin,	5	2	1	2
Gardner,	28	5	14	9
Georgetown,	1	-	1	-
Great Barrington,	1	-	-	1
Groton,	6	-	6	-
Hamilton,	2	-	2	-
Hanover,	13	1	3	9
Hanson,	2	1	-	1
Harvard,	5	2	2	1
Harwich,	8	1	5	2
Hingham,	42	7	23	12
Holbrook,	9	2	5	2
Holliston,	4	2	-	2
Holyoke,	1	-	1	-
Hubbardston,	1	-	1	-
Hudson,	9	1	4	4
Hull,	44	8	16	20
Huntington,	1	1	-	-
Hyde Park,	37	8	9	20
Ipswich,	29	2	2	25

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Kingston,	8	1	5	2
Lawrence,	1	-	1	-
Lexington,	1	-	1	-
Littleton,	9	1	4	4
Ludlow,	4	1	1	2
Lynnfield,	1	-	1	-
Malden,	26	1	6	19
Manchester,	7	-	2	5
Mansfield,	75	9	16	50
Marblehead,	51	8	27	16
Marion,	17	2	7	8
Marlborough,	42	9	10	23
Marshfield,	1	-	1	-
Mattapoisett,	1	-	1	-
Maynard,	2	-	2	-
Medfield,	146	16	118	12
Medford,	156	29	64	63
Medway,	3	-	2	1
Melrose,	83	16	35	32
Merrimac,	34	6	2	26
Methuen,	4	-	4	-
Middleborough,	42	8	13	21
Middleton,	18	3	11	4
Millis,	2	-	2	-
Milton,	41	4	24	13
Natick,	7	-	7	-
Needham,	13	1	10	2
Newbury,	1	-	-	1
Newburyport,	14	5	5	4
Norfolk,	1	-	1	-
North Adams,	6	-	5	1
North Andover,	3	2	1	-
North Attleborough,	16	6	4	6
North Reading,	14	1	5	8
Northborough,	1	-	1	-
Northfield,	6	1	2	3
Norton,	9	1	7	1
Norwell,	5	3	2	-

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Norwood,	44	5	17	22
Oak Bluffs,	1	-	1	-
Orange,	5	-	-	5
Peabody,	17	3	6	8
Pembroke,	6	1	3	2
Pepperell,	1	1	-	-
Petersham,	4	-	4	-
Plymouth,	30	11	14	5
Plympton,	1	-	-	1
Provincetown,	17	6	5	6
Quincy,	41	8	30	3
Randolph,	2	1	1	-
Raynham,	1	-	-	1
Reading,	19	3	9	7
Revere,	54	5	36	13
Rockland,	54	7	20	27
Rockport,	27	2	6	19
Rowe,	9	2	-	7
Russell,	3	-	3	-
Salem,	119	15	35	69
Sandwich,	1	-	1	-
Saugus,	53	4	18	31
Scituate,	10	2	2	6
Sharon,	59	18	12	29
Sheffield,	5	2	1	2
Shelburne,	5	1	2	2
Shirley,	32	6	14	12
Somerville,	3	1	2	-
Southborough,	1	-	1	-
Southbridge,	48	8	12	28
Southwick,	1	-	1	-
Spencer,	7	2	1	4
Stoneham,	71	10	19	42
Stoughton,	30	13	9	8
Swampscott,	4	-	-	4
Taunton,	17	4	10	3
Templeton,	6	2	2	2
Tewksbury,	1	-	1	-

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Topsfield,	6	–	5	1
Townsend,	1	–	1	–
Truro,	1	1	–	–
Uxbridge,	1	–	1	–
Wakefield,	18	4	6	8
Walpole,	25	4	12	9
Waltham,	8	–	8	–
Wareham,	8	1	2	5
Warren,	7	3	1	3
Watertown,	57	7	20	30
Webster,	6	2	1	3
Wenham,	1	–	1	–
Westborough,	22	5	7	10
Westfield,	18	6	8	4
Westford,	10	2	3	5
Westminster,	2	–	–	2
Westport,	12	2	2	8
Westwood,	12	2	4	6
Weymouth,	94	14	43	37
Whitman,	14	1	2	11
Wilbraham,	1	–	–	1
Williamstown,	3	–	3	–
Wilmington,	8	2	4	2
Winchendon,	11	–	7	4
Winchester,	61	6	40	15
Winthrop,	85	12	20	53
Woburn,	39	11	21	7
Wrentham,	1	1	–	–
Totals,	3,531	584	1,371	1,576

REPORT UPON THE EXAMINATION OF SPUTUM AND OTHER MATERIAL SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

From Dec. 1, 1909, to Nov. 30, 1910, microscopical examination has been made of 1,997 lots of sputum and other material suspected of containing the bacilli of tuberculosis. This material has been received from 182 cities and towns in the State. The following table gives the places from which the material has been received and the results of the microscopical examination: —

City or Town.	Whole Number of Examinations.	Positive.	Negative.	City or Town.	Whole Number of Examinations.	Positive.	Negative.
Abington,	7	1	6	**Bourne,**	1	-	1
Acton,	2	1	1	**Braintree,**	9	3	6
Adams,	33	11	22	**Bridgewater,**	8	2	6
Amesbury,	31	7	24	**Brockton,**	4	2	2
Andover,	9	3	6	**Brookfield,**	2	1	1
Arlington,	20	7	13	**Brookline,**	1	1	-
Ashland,	18	1	17	**Burlington,**	2	1	1
Athol,	4	1	3	**Cambridge,**	2	1	1
Attleborough,	60	14	46	**Canton,**	13	4	9
Avon,	2	-	2	**Charlemont,**	1	-	1
Ayer,	2	-	2	**Chelmsford,**	4	-	4
Barnstable,	2	-	2	**Chelsea,**	76	10	66
Barre,	4	-	4	**Chicopee,**	1	1	-
Becket,	1	-	1	**Clarksburg,**	2	-	2
Bedford,	4	-	4	**Cohasset,**	7	2	5
Belmont,	4	1	3	**Concord,**	12	3	9
Berkley,	5	3	2	**Cummington,**	1	-	1
Beverly,	19	2	17	**Dalton,**	1	1	-
Blackstone,	15	6	9	**Danvers,**	35	4	31
Boston,	17	6	11	**Dartmouth,**	3	2	1

CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.
Dedham,	17	8	9
Dennis,	3	2	1
Dighton,	5	2	3
Dover,	1	-	1
Duxbury,	4	-	4
East Bridgewater,	9	2	7
Everett,	97	25	72
Fall River,	1	1	-
Falmouth,	5	2	3
Foxborough,	11	-	11
Framingham,	29	3	26
Franklin,	3	1	2
Gardner,	14	5	9
Gill,	3	-	3
Gloucester,	26	11	15
Great Barrington,	17	4	13
Greenfield,	1	-	1
Groton,	1	-	1
Groveland,	1	-	1
Hadley,	1	-	1
Hamilton,	4	1	3
Hampden,	1	-	1
Hanover,	5	2	3
Hanson,	2	1	1
Harwich,	3	-	3
Haverhill,	4	1	3
Hingham,	6	1	5
Holbrook,	5	-	5
Holden,	3	1	2
Holliston,	4	-	4
Hopedale,	10	2	8
Hopkinton,	1	1	-
Hudson,	5	1	4
Hull,	3	1	2
Hyde Park,	18	7	11
Ipswich,	17	3	14
Kingston,	1	-	1
Lancaster,	1	-	1
Lawrence,	2	-	2
Lee,	3	1	2
Lenox,	3	3	-
Lexington,	30	6	24
Lincoln,	3	-	3
Lynn,	5	1	4
Malden,	9	2	7
Manchester,	6	-	6
Mansfield,	23	2	21
Marion,	4	-	4
Marlborough,	25	8	17
Marshfield,	2	1	1
Mattapoisett,	1	-	1
Maynard,	12	6	6
Medfield,	4	-	4
Medford,	49	11	38
Melrose,	56	10	46
Mendon,	3	1	2
Merrimac,	3	2	1
Middleborough,	10	2	8
Middleton,	3	1	2
Milford,	37	9	28
Milton,	4	1	3
Montague,	1	1	-
Nahant,	1	-	1
Nantucket,	1	1	-
Natick,	18	7	11
Needham,	10	-	10
New Marlborough,	2	1	1
Newburyport,	6	1	5
Newton,	1	-	1
North Adams,	11	3	8
North Andover,	1	-	1
North Attleborough,	34	5	29

City or Town.	Whole Number of Examinations.	Positive.	Negative.
Northampton,	1	-	1
Northfield,	10	2	8
Norton,	5	-	5
Norwood,	26	11	15
Orange,	1	-	1
Orleans,	2	1	1
Oxford,	2	2	-
Palmer,	1	-	1
Peabody,	21	4	17
Petersham,	2	1	1
Pittsfield,	23	3	20
Plymouth,	8	3	5
Quincy,	72	19	53
Randolph,	3	1	2
Raynham,	1	1	-
Reading,	36	3	33
Revere,	21	10	11
Rochester,	1	1	-
Rockland,	22	3	19
Rockport,	6	1	5
Rowley,	1	-	1
Salem,	138	31	107
Sandwich,	6	3	3
Saugus,	12	-	12
Scituate,	3	1	2
Shelburne,	2	-	2
Sherborn,	3	2	1
Shirley,	11	4	7
Somerville,	5	2	3
Southborough,	1	-	1
Spencer,	6	2	4
Stoneham,	6	1	5
Stoughton,	10	3	7
Sunderland,	2	-	2
Sutton,	1	1	-
Swampscott,	2	1	1
Taunton,	107	27	80
Templeton,	3	-	3
Tewksbury,	2	-	2
Townsend,	3	1	2
Upton,	7	5	2
Uxbridge,	1	-	1
Wakefield,	17	5	12
Walpole,	8	1	7
Waltham,	1	-	1
Wareham,	7	5	2
Warren,	9	3	6
Watertown,	10	3	7
Wayland,	4	1	3
Webster,	1	1	-
Wellfleet,	1	-	1
Wenham,	6	1	5
West Brookfield,	6	-	6
West Newbury,	1	-	1
Westborough,	1	-	1
Westfield,	22	4	18
Westford,	10	-	10
Weston,	2	-	2
Westport,	2	-	2
Westwood,	1	-	1
Weymouth,	17	2	15
Whitman,	10	1	9
Williamsburg,	3	1	2
Williamstown,	6	2	4
Wilmington,	13	3	10
Winchendon,	7	2	5
Winchester,	28	3	25
Winthrop,	19	4	15
Woburn,	18	2	16
Wrentham,	2	1	1
Totals,	1,997	471	1,526

TYPHOID FEVER.

WIDAL, AGGLUTINATIVE OR SERUM TEST.

During the year ended Nov. 30, 1910, the Widal test was carried out with 874 specimens of blood. Of these specimens, 168, or 19.2 per cent., gave a positive reaction. Specimens were sent from 128 cities and towns. These facts are shown in detail in Table I. In a second table (Table II.) the specimens, positive and negative, are classified according to the day of the disease on which they were collected. A moderate number of second and third specimens from the same case were examined, so that the total nnmber of tests made is somewhat over the number of cases of disease concerned. The methods used during the year were the same as those previously in use in the laboratory, and they have been amply described in the reports of the year 1900 and the years following.

TABLE I. — *Widal Test, Dec. 1, 1909, to Nov. 30, 1910, inclusive, classified according to the City or Town from which the Specimen was sent.*

CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.	CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.
Abington,	6	-	6	**Brewster,**	2	-	2
Acton,	2	-	2	**Brimfield,**	1	-	1
Amesbury,	2	1	1	**Cambridge,**	1	1	-
Amherst,	1	-	1	**Canton,**	5	-	5
Arlington,	9	1	8	**Chelmsford,**	1	-	1
Attleborough,	28	6	22	**Chelsea,**	13	2	11
Avon,	1	-	1	**Cohasset,**	4	-	4
Barnstable,	2	-	2	**Concord,**	6	-	6
Belmont,	1	1	-	**Danvers,**	4	1	3
Beverly,	16	2	14	**Dartmouth,**	2	-	2
Billerica,	1	-	1	**Dedham,**	8	2	6
Blackstone,	3	1	2	**Deerfield,**	1	-	1
Boston,	2	1	1	**Dennis,**	5	-	5
Braintree,	5	-	5	**Dighton,**	3	1	2

TABLE I. — *Widal Test, etc.* — Continued.

CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.	CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.
Douglas,	1	-	1	Marshfield,	2	-	2
Dover,	2	-	2	Maynard,	7	2	5
Duxbury,	4	1	3	Medford,	17	1	16
East Bridgewater,	3	2	1	Melrose,	14	2	12
Everett,	35	5	30	Middleborough,	3	1	2
Fall River,	1	-	1	Milford,	10	1	9
Franklin,	1	1	-	Millis,	4	-	4
Freetown,	1	1	-	Milton,	2	-	2
Gardner,	2	1	1	Monroe,	1	-	1
Gloucester,	11	2	9	Nantucket,	2	1	1
Goshen,	1	-	1	Natick,	49	13	36
Groton,	1	-	1	Needham,	5	-	5
Hadley,	2	-	2	Newburyport,	1	-	1
Hamilton,	1	-	1	Newton,	4	2	2
Hanover,	3	-	3	Norfolk,	1	-	1
Hanson,	1	-	1	North Adams,	7	3	4
Haverhill,	1	-	1	North Attleborough,	13	2	11
Hingham,	3	-	3	North Brookfield,	1	-	1
Holbrook,	3	1	2	Northampton,	21	3	18
Holden,	3	-	3	Northfield,	1	-	1
Hopedale,	2	2	-	Norwood,	6	2	4
Hopkinton,	2	-	2	Palmer,	1	-	1
Hudson,	6	2	4	Peabody,	1	-	1
Hull,	16	5	11	Pembroke,	2	1	1
Hyde Park,	16	2	14	Petersham,	1	-	1
Ipswich,	3	-	3	Pittsfield,	1	1	-
Kingston,	1	-	1	Plymouth,	1	1	-
Lakeville,	2	-	2	Quincy,	22	1	21
Lancaster,	1	-	1	Randolph,	2	1	1
Lawrence,	8	2	6	Reading,	3	-	3
Lincoln,	5	-	5	Revere,	8	-	8
Lynn,	121	21	100	Rockland,	2	-	2
Marblehead,	6	-	6	Rockport,	14	3	11
Marlborough,	32	10	22	Russell,	5	-	5

TABLE I. — *Widal Test, etc.* — Concluded.

CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.	CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.
Salem,	4	-	4	Wellesley,	4	-	4
Saugus,	10	3	7	Westfield,	1	-	1
Scituate,	1	-	1	Westford,	2	-	2
Sherborn,	1	-	1	Westport,	9	1	8
Shirley,	2	-	2	Westwood,	4	3	1
Somerville,	2	1	1	Weymouth,	2	-	2
Southborough,	1	-	1	Whitman,	3	1	2
Stoneham,	17	4	13	Williamsburg,	1	-	1
Stoughton,	1	-	1	Wilmington,	1	-	1
Swampscott,	10	2	8	Winchester,	14	4	10
Taunton,	36	5	31	Winthrop,	9	3	6
Wakefield,	5	3	2	Woburn,	20	3	17
Waltham,	1	-	1	Worcester,	1	-	1
Wareham,	1	-	1	Wrentham,	1	-	1
Warren,	2	1	1	Yarmouth,	1	-	1
Watertown,	7	2	5	Totals,	874	168	706
Wayland,	30	13	17				

TABLE II. — *Widal Test, according to Stage of Disease, Dec. 1, 1909, to Nov. 30, 1910, inclusive.*

APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD.	NUMBER OF CASES.		APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD.	NUMBER OF CASES.	
	Positive.	Negative.		Positive.	Negative.
1,	1	6	11,	14	30
2,	-	7	12,	8	20
3,	3	25	13,	11	23
4,	4	21	14,	9	46
5,	4	33	15,	5	22
6,	5	29	16,	4	14
7,	11	62	17,	4	8
8,	7	45	18,	4	10
9,	13	44	19,	2	9
10,	16	38	20,	2	12

TABLE II. — *Widal Test, etc.* — Concluded.

APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD.	NUMBER OF CASES.		APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD.	NUMBER OF CASES.	
	Positive.	Negative.		Positive.	Negative.
21,	1	18	37,	-	1
22,	3	4	40,	-	1
23,	1	10	42,	-	2
24,	3	3	43,	-	3
25,	-	3	44,	-	1
26,	-	2	46,	1	-
27,	-	3	48,	1	-
28,	-	5	49,	1	1
29,	-	1	55,	-	1
30,	-	1	58,	-	1
31,	1	2	59,	1	-
32,	-	1	4 months,	-	1
34,	1	2	Not stated,	26	132
35,	1	3	Totals,	168	706

MALARIA.

From Dec. 1, 1909, to Nov. 30, 1910, 56 blood specimens were received, to be examined for the presence or absence of malaria parasites. Of these, 10 were positive and 46 were negative. The percentage of positive cases was 17.9.

The following table shows the city or town from which the specimens, positive and negative, were derived: —

CITY OR TOWN.	Number of Cases.	Positive.	Negative.
Arlington,	1	-	1
Boston,	2	-	2
Concord,	2	-	2
Dedham,	1	-	1
Hull,	2	-	2
Hyde Park,	1	-	1
Lynn,	2	2	-
Medford,	1	-	1
Melrose,	4	-	4
Milton,	1	-	1
Natick,	20	4	16
Norwood,	3	2	1
Saugus,	4	2	2
Walpole,	2	-	2
Waltham,	1	-	1
Winchester,	7	-	7
Winthrop,	2	-	2
Totals,	56	10	46

REPORT UPON INVESTIGATIONS

OF

LOCAL OUTBREAKS OF INFECTIVE DISEASES.

[illegible] Sheppard, M.D., Boston. Reprinted from the Boston Med. and Surg. Jour. May [illegible]

[2] Jour. Am. Med. Asso., Feb. 18, 1911, p. 495.

[3] *Ibid.*, Feb. 25, 1911, p. 585.

REPORT UPON INVESTIGATIONS OF LOCAL OUTBREAKS OF INFECTIVE DISEASES.

Accounts of outbreaks of infective diseases which have been investigated by State Inspectors of Health are recorded in another portion of the annual report under the heading "Fourth Annual Report on the Work of the State Inspectors of Health."

THE OCCURRENCE OF INFANTILE PARALYSIS IN MASSACHUSETTS IN 1910.[1]

The last year has been one of considerable progress in our knowledge of infantile paralysis. The disease has been widespread in the United States; 23 States have made the disease reportable, and several State boards of health have taken up the work of investigation. The clinical study of cases has become more accurate and careful, and the importance and frequency of abortive cases has been much more fully recognized.

Three certain interesting contributions to our knowledge are as follows: —

Osgood and Lucas found an active virus in the naso-pharyngeal membrane of one monkey, who had recovered from the acute attack, five and one-half months afterward, and in another six weeks afterward. This virus was sufficiently active to cause paralysis in a first and second generation of monkeys into which it was injected.[2]

The second contribution is from Flexner and Clark.[3] It has been previously shown that if hexamethylenamin is administered by mouth, its presence can be detected in the cerebro-spinal fluid. Flexner and Clark showed that if the drug be given by mouth, and its use continued after its presence in the spinal fluid can be detected in monkeys, and if such animals are subsequently inoculated either subdurally or by the intracerebral route, the paralysis is in a certain proportion of cases delayed or prevented. But successful results by the drug have so far been obtained in inhibiting infection, and not in restraining an already established infection. In other words, there is as yet an absence of experimental evidence to show that the drug is of much use when the disease has begun.

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[1] Reported for the Massachusetts State Board of Health, by Robert W. Lovett, M.D., Boston, and Philip A. E. Sheppard, M.D., Boston. Reprinted from the Boston Med. and Surg. Jour. May 25, 1911.

[2] Jour. Am. Med. Asso., Feb. 18, 1911, p. 495.

[3] *Ibid.*, Feb. 25, 1911, p. 585.

A third contribution by Anderson and Frost[1] is as follows: It is only very recently that it has been found possible by a laboratory method to throw back light on whether a suspicious case occurring in the past may or may not have been abortive infantile paralysis. It is possible by means of neutralization tests to determine this matter by mixing the blood serum of the recovered case with the filtered virus, and injecting the mixture into a monkey, the serum of recovered cases having the power of neutralizing a certain amount of the virus.

By a study of the changes in the cerebro-spinal fluid in monkeys preceding the paralysis, a forecast of the probable changes in man was worked out, and paralysis predicted in a human case where a lumbar puncture was done early. The case is reported by Frissell.[2] The changes are the following: At the height of the lesions in the meninges it has been found in monkeys and confirmed in a human case that the cerebro-spinal fluid is slightly turbid or opalescent, and contains an excess of protein. There is a large increase of white cells, both poly- and mononuclear. The fluid may in some cases be distinctly turbid, and polynuclear cells may predominate. Paralysis occurs at the height of these changes, and then the changes described in the fluid begin to disappear.

In the matter of etiology more attention has been paid to dust, and the data reported by Hill[3] are suggestive. In Winona, Minn., there were 29 cases up to the end of July, 27 occurring on dusty streets. On August 5 street watering was begun at the suggestion of the State and local health officials, and no case occurred in Winona after August 12, although the greatest incidence throughout the State had yet to develop, and the neighborhood outside of Winona continued to show cases. Hill quotes also three other instances in the State of a similar occurrence.

The need of quarantine is being appreciated, and the experience in Nebraska is worth quoting:[4] "We were informed that no legal provision had been made for quarantining such cases, and isolation was recommended, but, of course, could not be enforced, nor could the impending Fourth of July celebration be abandoned. This celebration was well attended, and shortly after cases were reported from communities previously free from the disease, and having had representatives present at the celebration. From May 30 to July 4 we had in the Stromsberg territory 30 cases, while from July 4 to August 3, just thirty days, we had 115 cases." A quarantine was declared necessary, and put into effect on July 22, and after August 3 there were only 15 cases in the Stromsberg territory.

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[1] Jour. Am. Med. Asso., March 4, 1911, p. 663.

[2] *Ibid.*, March 4, 1911, p. 661.

[3] Trans. Prev. Med. of Am. Med. Asso., 1910.

[4] Anderson: Pediatrics, August, 1910.

The salient points in progress may be summarized as follows: —

(1) A decidedly keener attitude on the part of the profession, the health boards and legislative bodies toward the disease.

(2) The knowledge that the infection may persist in the nasopharynx in monkeys for long periods.

(3) The possibility of diagnosticating after recovery the character of abortive cases.

(4) The possibility of early diagnosis by means of lumbar puncture.

(5) The possibility that hexamethylenamin may be in monkeys at times a preventive of infection, but does not apparently control established infection.

During the year 1910 the Massachusetts State Board of Health continued for the fourth consecutive year the investigation of infantile paralysis as it occurred in the State.[1]

The disease having been made a reportable one in November, 1909, the Board received notice of cases reported by physicians, and to them blanks were sent to be filled out and returned. Dr. Philip A. E. Sheppard and Dr. T. P. Hennelly were employed by the Board to investigate the cases at their homes, to make an intensive study of epidemic centers and to see as many other cases reported as practicable. The scope and direction of the inquiry have again been supervised by an advisory committee, consisting of Dr. Theobald Smith, Dr. Milton J. Rosenau, Dr. James H. Wright and Dr. John Lovett Morse, who have met at frequent intervals the secretary of the Board and the members concerned in the inquiry. The Legislature of 1910 generously appropriated the sum of $5,000 for the purposes of this investigation.

The data relating to the disease in the State during the year 1910 will be here presented, and later, in another form, will be presented those conclusions that seem warranted by a study of the disease in Massachusetts for four years, with certain general considerations with regard to the disease. The investigation will be continued in 1911 on a more extended scale, $10,000 having been appropriated for the purpose by this year's Legislature.

There are three classes of cases to be reported on: —

(1) The total cases reported by physicians with their location, — 845.

(2) The number of cases for which blanks were filled out, — 601.

(3) A group of cases carefully studied by the medical investigators of the Board, — 200.

The groups of cases considered in various respects will, therefore, differ in number, more space in general being allotted to the 200 carefully studied than to the others.

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[1] Boston Med. and Surg. Jour., 1908, CLIX, p 131; *Ibid.*, 1909, July 22; *Ibid.*, 1910, CLXIII, p. 37; Am. Jour. Pub. Hyg., November, 1910, p. 875.

The record of the last four years is as follows: —

YEAR.	Cases.	Cities and Towns with Cases.	YEAR.	Cases.	Cities and Towns with Cases.
1907,	234	75	1909,	923	136
1908,	136	47	1910,	845	153

The distribution of the cases is seen in the map, from which it will be seen that marked epidemic centers existed in Springfield and Fall River, with a suggestion of a minor epidemic center in Boston. The number of cities and towns affected was larger in 1910 than in 1909, when there was a greater total number of cases.

Deficiency Rainfall, 1904–10, Inclusive (Inches).

YEAR.	Cases in State.	Actual.	Normal.	Deficiency.
1904,	-	43.81	45.16	—1.35
1905,	-	37.60	-	—7.56
1906,	-	43.21	-	—1.95
1907,	234	44.49	-	—0.67
1908,	136	37.61	-	—7.55
1909,	923	42.10	-	—3.06
1910,	845	35.50	-	—9.42
				—31.56

A consideration of this table shows that for the last four years the driest years have not been attended by the largest number of cases in Massachusetts.

The comparison of the rainfall by months and the incidence of the disease shows that in 1910 August was the driest of the three summer months, and also the one in which the largest number of cases occurred. August was also the month with the highest mean temperature, so that both drought and heat were at their height when the largest number of cases occurred.

Analysis of Cases thoroughly studied (200 Cases in 186 Families).

Total number of children,		488
Number of contemporaneous illnesses in children and adults,		253
Number of children paralyzed,	172	
Number of adults paralyzed,	28	
		200
Possible abortive cases,		53

An investigation of the nearness of the affected house to railroad and highroad showed no preponderating number close to either, 15 per cent.

being close to a railroad and about 60 per cent. on the highroad. The nearness to water in the 200 cases studied in and around Springfield showed 17 per cent. within one-eighth mile of the river, 35 per cent. within one-fourth mile and the rest at greater distances. Of the remaining cases in other localities, in the great majority of cases where it was stated, the house was not near the water.

SURROUNDINGS OF PATIENTS.

Age of house. — The affected house was a new house, that is, less than ten years old, in 27 per cent. of the cases, and over 10 years old in the remainder, and an investigation of the *sanitary condition* of the house showed, as in former years, that in most cases such conditions ranged from fair to excellent. In 74 per cent. of the cases the location was given as "dry," and as "damp" in the remainder.

An investigation of the *water supply* and *sewage disposal* showed in the great majority of cases city and metropolitan water supply and sewage disposal, so that no common factor is to be found in either of these elements which might be assigned as a possible cause.

Dust. — The amount of dust in affected localities was most carefully inquired into, but there is no standard of measurement, and the information in the following table must be regarded as only approximately accurate: —

	Cases.
No dust,	156
Very little dust,	124
Much dust,	123
Moderate amount of dust,	172
Excessive amount of dust,	7
Not stated,	77

In this connection the treatment of streets on which cases occurred was investigated. The results were as follows: —

	Cases.
No treatment,	316
Watered,	162
Oiled,	32
Watered and oiled,	16
Not stated,	75
	601

Digging or *excavating* in the neighborhood of affected houses had been in progress in a little over 15 per cent. of 334 cases where data existed on this point.

Presence of Insects, Vermin, Rodents, etc.

Among 185 families, 185 had insects, etc., as follows: —

	Families.
Flies were present in	185
Mosquitoes were present in	67
Ants were present in	62
Mice (house) were present in	60
Bedbugs were present in	39
Roaches were present in	29
Spiders were present in	26
Rats were present in	23
Biting flies were present in	7
Field mice were present in	4
Fleas were present in	2
Bees were present in	2
Sand fleas were present in	1
Snakes were present in	1
Crickets were present in	1
Squirrels were present in	1
Leeches were present in	1

As to *insect bites,* there was no such history in 70 per cent. of 200 cases carefully investigated; a history of mosquito bites in 27 per cent. and in the remainder bites from various insects were recorded.

Any investigation as to the prevalence of an especial insect in a given locality, which is to be of much value, must be made on the spot by a person skilled in entomology, and definite conclusions cannot be based on the above table.

Data as to Illness in Domestic Animals and Birds.

Of 186 families: —

No animal of any kind in	76
Animals present in	110
	186

Thus: —

(*a*) 27 homes had 31 dogs without sickness.
50 homes had 66 cats without sickness.
39 homes had about 745 hens and chickens without sickness.
11 homes had 18 horses without sickness.
3 homes had 3 cows without sickness.
4 homes had 4 canaries without sickness.
10 homes had 2 goldfish without sickness.
1 home had 5 geese without sickness.

1 home had 10 ducks without sickness.
1 home had 10 pigeons without sickness.
(*b*) 6 homes had 14 hens with sickness.
6 homes had 6 hens with sickness.
(*c*) 4 homes had 4 dogs with paralysis.
4 homes had 12 hens with paralysis.
(*d*) 2 homes had deaths in 2 dogs.
6 homes had deaths in 6 cats.
8 homes had deaths in 42 hens.
2 homes had deaths in 2 horses.

Total, 34 homes out of 110 had illness, paralysis or death in 82 animals near the time of the human paralysis.

As to paralysis in domestic animals, a veterinary surgeon, Dr. A. W. May, was employed by the Board in the autumn of 1910 to visit kennels, poultry farms, veterinary hospitals, etc., through as much of the State as possible, in order to see if the distribution of animal paralysis corresponded to that of the human disease. His report will be published separately.

Other data, not given in former reports, follow: —

Nativity.

	Cases.
American,	315
French Canadian,	33
French,	51
French American,	5
Irish American,	65
Polish,	19
Portuguese,	13
Hebrew,	15
Italian,	11
English,	9
English American,	2
Irish,	4
French Irish,	2
Colored,	6
Swedish,	15
German American,	6
Greek,	5
Finlander,	2
Nova Scotian,	2
Scotch,	4
Austrian,	1
Bohemian,	1
Not stated,	15
	601

This table is important as showing that the apparent partial immunity of the colored race may be less true than had been supposed, the relative incidence in Massachusetts in 1910 per thousand of population being in the colored race .17, and in the white .20. In order to obtain the incidence among the colored race in a community thoroughly infected, this was calculated for Springfield, where, in a colored population of 1,294, there occurred 4 cases, an incidence of 3.09 per thousand, while in the white population of the same city the incidence was 1.99 per thousand.

COMMUNICABILITY.

The question of communicability is probably obscured by the existence of abortive cases. The data here presented were established with all possible care. In 200 cases there was certain direct contact with an acute case in 32 cases, indirect contact in 10, and direct contact with a possible abortive case in 4. Out of 186 families, 13 had 2 cases and 1 family had 3.

There were no lodgers in 176 families of 186 investigated in this regard, and 18 lodgers in the 10 other families.

CONDITIONS PRECEDING THE ATTACK.

Swimming and *Wading*. — Out of 524 cases when the question was answered, it was stated that 15.8 per cent. of the patients were swimming, wading or paddling in water just before the attack, while the remainder were not.

In 1909, out of 150 cases, 40.8 per cent. gave such a history on account of the different locality investigated last year, which may serve as a reminder that in estimating the possible effect of etiological factors too much importance cannot be attached to investigations confined to one locality.

Exposure to heat, cold or *dampness* just preceding the attack occurred in the history of 27 per cent. of 575 cases and was absent in the rest.

An *accident, fall* or *overexertion* was noted in 23 per cent. of 573 cases just before the attack.

DIET.

The majority of the patients ate of several kinds of food. In the analysis of a series of 200 cases studied in and around Springfield, 4 babies, all under six months, were said to be fed on breast milk alone. The other data as to diet were not apparently of especial interest, many articles of food being given, from a study of which no conclusive data can be drawn.

By Age Periods.

	Cases.	Per Cent. Approximate.
From birth to twelve months, inclusive,	51	8.5
From thirteen months to twenty-three months, inclusive,	65	
Two years old,	61	
Three years old,	98	
Four years old,	69	
Five years old,	51	65.5
	395	
Six to ten years, inclusive,	93	80.8
	488	
Eleven to twenty years, inclusive,	69	92.1
	557	
Twenty-one to thirty years, inclusive,	28	
Thirty-one to eighty years, inclusive,	15	
	600	

It is evident by a comparison with the table for 1909, that in 1910 a larger number of older children were attacked, the percentage of all cases from one to ten inclusive being 87.48 in 1909, while in 1910 only 80.8 per cent. of the same age were attacked.

Mortality by Age.

	Cases.	Deaths.	Mortality (Per Cent.).
Under one year,	38	3	7.89
One to ten years,	451	39	8.64
Over ten years,	112	12	10.71
Total,	601	54	-
Average mortality,	-	-	8.98

The total mortality was 1 per cent. higher than in 1909.

INCIDENCE OF THE DISEASE.

Sex. — There were 331 males and 270 females affected.

The condition of the patient preceding the attack was given in 540 cases; in about 30 per cent. the patient had been perfectly well and in about 60 per cent. some abnormal condition existed either some time before or just previous to the attack. Malaise existed in about 20 per cent., affection of the throat or respiratory passages in 9 per cent., gastric or intestinal disturbance in 11 per cent. and in the remainder a variety of illnesses, the only group of significance being 10 cases where operation, wounds or sores preceded the attack. A study of the *recent illnesses in members of the same family* showed nothing of apparent importance, a moderate number of ordinary illnesses being recorded, chiefly of the upper respiratory passages and digestive tract.

General Features of Acute Attack for 601 Cases.

540 cases give history of fever.
487 cases give history of pain and tenderness.
284 cases give history of brain symptoms.
209 cases give history of retraction.
92 cases give history of sore throat.
2 cases give history of nystagmus.
1 case gives history of hiccough.

Digestive disturbance during the attack occurred in about 75 per cent. of the cases, this disturbance being nausea and vomiting, constipation or diarrhœa, with colic in a few cases.

Disturbance of the bladder did not occur in 73 per cent. of the cases, but retention was noted in 20 per cent. of the cases and other minor disturbances in the remainder.

Pain and Tenderness.

	Cases.
Pain or tenderness was present in	469
Pain or tenderness was absent in	42
Pain or tenderness was not stated in	90
	601

Pain or Tenderness lasted.

	Cases.
No pain,	42
One day or less,	9
Two days,	14
Three days,	20
Four days,	15
Five days,	10
Six days,	6
One week,	35
One to two weeks,	41
Two to three weeks,	32
Three to four weeks,	18

	Cases.
Four to five weeks,	8
Five to six weeks,	4
Eight to nine weeks,	5
Nine to ten weeks,	1
A few days,	25
Until death,	45
Present when report made,	181
Not stated,	90
	601

Appearance of Paralysis in Days and Weeks after Onset of Fever.

	Cases.
Same day,	20
One day,	31
Two days,	40
Three days,	34
Four days,	15
Five days,	11
Six days,	11
Seven days,	14
Eight days,	4
Nine days,	2
Ten days,	2
Eleven days,	2
Twelve days,	4
Thirteen days,	1
Fourteen days,	1
Two to three weeks,	5
Three to four weeks,	1
Four to five weeks,	1
Eight weeks,	1
	200

Distribution of Early Paralysis.

	Cases.
One leg only,	145
Both legs only,	146
One arm only,	44
Both arms only,	12
One arm and leg, same side,	50
One arm and leg, opposite sides,	18
Both legs and one arm,	32
Both arms and one leg,	8
Both arms and both legs,	51
Ataxia (transitory),	7

	Cases.
Back,	79
Abdomen,	38
Neck,	13
Respiration,	39
Deglutition,	12
Intercostal,	1
Face,	7
Right face,	31
Left face,	24
Strabismus,	2
Not stated,	32

Nine cases out of 200 gave a history of some *skin eruption* appearing on the chest or around the neck, or about the girdle.

In one or two such cases there was noted by the investigator a small maculo-papular rash, — a faint blush underlying the area with no definite redness to base of vesicle.

PROGNOSIS.

Up to the time of assembling the Board's report (a period of six months after the beginning of the epidemic outbreak in western Massachusetts), 27 cases (13.5 per cent.) out of 200 had completely recovered.

A study of the age, distribution of the early paralysis and duration of tenderness and paralysis in these cases leads to the conclusion that the early symptoms offered no means of distinguishing them from cases where the paralysis was to be permanent.

CONCLUSIONS.

The disease in Massachusetts was nearly as prevalent in 1910 as in the previous year, and affected 153 cities and towns instead of 136, as in 1909. But one must remember that a much larger proportion of cases is now recognized and reported in Massachusetts than was formerly the case, so that probably the apparently relative prevalence of the disease in Massachusetts when compared to other States, the total number of cases in the State and the apparent spread are in some measure due to the alert attitude of the medical profession of this State in recognizing and reporting cases.

A large epidemic center existed in Springfield, with 148 cases in the city and a large number in the surrounding towns, the distribution appearing to be radial from Springfield. Another epidemic center existed in Fall River, with 89 cases in the city and more or less radial distribution to contiguous towns.

It is evident that the disease has existed in all classes in the community, as is evident from the report on the sanitary conditions under which the patient lived, and also that it exists under all conditions of sewage disposal and with all kinds of water supply. Our researches in the last two years have failed to show an excessive amount of dust in affected localities.

The proportion of affected houses in which contemporaneous sickness, paralysis or death existed in domestic animals or birds still seems larger than one would naturally expect.

The occurrence of 6 cases in the colored race is of importance in connection with the data of other investigators, who have found the race rarely affected.

The facts given with regard to communicability are to be regarded as important, 42 such histories having been obtained in 200 cases.

No definite information as to any one factor is to be found in the antecedents of the attack, since bathing, falls, exposure to heat, overexertion, etc., are common occurrences in children of the affected age in the summer season; nor in the study of diet does there seem much of importance except for the existence of the disease in 4 nursing babies.

The fact has been commented on that the disease was a little more prevalent this year in older children than in 1910.

The study of the immediate antecedents of the attack and the early symptoms show nothing of especial present interest except the very common occurrence of pain and tenderness, and the information as to its duration is of value.

The distribution of paralysis was made by a skilled investigator in a group of cases carefully studied, and it is important to note under those conditions the comparatively frequent involvement of the back, abdomen, neck and face, — a matter often overlooked.

The per cent. of total recoveries from the paralysis within a period of six months and less after the attack was 13.5 in 200 cases, as against a per cent. of 16.7 in a similar class of cases in 1909.

For the year 1911 the State Board of Health intends to pursue the same investigation as in the four previous years, on a more extended scale, hoping by a study of the disease in one locality over a term of years to reach some conclusions as to its characteristics.

As in former years the Board is under great obligations to the medical profession for their ready co-operation at all points, and asks for the coming year the same ready assistance.

FOURTH ANNUAL REPORT

ON THE

WORK OF THE STATE INSPECTORS OF HEALTH.

BY THE ASSISTANT TO THE SECRETARY OF THE BOARD.

FOURTH ANNUAL REPORT ON THE WORK OF THE STATE INSPECTORS OF HEALTH.

By the Assistant to the Secretary of the Board.

CITIES AND TOWNS INCLUDED IN EACH HEALTH DISTRICT.

Health District No. 1. — Includes the cities of Fall River and New Bedford, and the towns of Acushnet, Barnstable, Bourne, Brewster, Chatham, Chilmark, Dartmouth, Dennis, Eastham, Edgartown, Fairhaven, Falmouth, Freetown, Gay Head, Gosnold, Harwich, Marion, Mashpee, Mattapoisett, Nantucket, Oak Bluffs, Orleans, Provincetown, Rochester, Sandwich, Somerset, Swansea, Tisbury, Truro, Wareham, Wellfleet, West Tisbury, Westport and Yarmouth.

Health District No. 2. — Includes the cities of Quincy and Taunton, and the towns of Attleborough, Avon, Bellingham, Berkley, Blackstone, Braintree, Canton, Dedham, Dighton, Easton, Foxborough, Franklin, Holbrook, Hyde Park, Mansfield, Milton, Norfolk, Norton, North Attleborough, Norwood, Plainville, Randolph, Raynham, Rehoboth, Seekonk, Sharon, Stoughton, Walpole, Westwood and Wrentham.

Health District No. 3. — Includes the city of Brockton, and the towns of Abington, Bridgewater, Carver, Cohasset, Duxbury, East Bridgewater, Halifax, Hanover, Hanson, Hingham, Hull, Kingston, Lakeville, Marshfield, Middleborough, Norwell, Pembroke, Plymouth, Plympton, Rockland, Scituate, West Bridgewater, Weymouth and Whitman.

Health District No. 4. — Includes the cities of Boston and Chelsea, and the towns of Revere and Winthrop.

Health District No. 5. — Includes the cities of Cambridge, Everett, Malden, Medford, Melrose, Somerville and Waltham, and the towns of Arlington, Belmont, North Reading, Reading, Stoneham, Wakefield and Watertown.

Health District No. 6. — Includes the cities of Marlborough and Newton, and the towns of Ashland, Brookline, Dover, Framingham, Grafton, Holliston, Hopedale, Hopkinton, Medfield, Medway, Mendon, Milford, Millis, Natick, Needham, Northborough, Sherborn, Shrewsbury, Southborough, Sudbury, Upton, Wayland, Wellesley, Westborough and Weston.

Health District No. 7. — Includes the cities of Beverly, Gloucester, Lynn and Salem, and the towns of Danvers, Essex, Hamilton, Ipswich, Lynnfield, Manchester, Marblehead, Middleton, Nahant, Peabody, Rockport, Saugus, Swampscott, Topsfield and Wenham.

Health District No. 8. — Includes the cities of Haverhill, Lawrence and Newburyport, and the towns of Amesbury, Andover, Boxford, Georgetown, Groveland, Merrimac, Methuen, Newbury, North Andover, Rowley, Salisbury and West Newbury.

Health District No. 9. — Includes the cities of Lowell and Woburn, and the towns of Acton, Ayer, Bedford, Billerica, Boxborough, Burlington, Carlisle, Chelmsford, Concord, Dracut, Dunstable, Groton, Harvard, Lexington, Lincoln, Littleton, Maynard, Pepperell, Shirley, Stow, Tewksbury, Townsend, Tyngsborough, Westford, Wilmington and Winchester.

Health District No. 10. — Includes the city of Fitchburg, and the towns of Ashburnham, Ashby, Athol, Barre, Berlin, Bolton, Boylston, Clinton, Dana, Gardner, Hardwick, Holden, Hubbardston, Hudson, Lancaster, Leominster, Lunenburg, New Braintree, Oakham, Paxton, Petersham, Phillipston, Princeton, Royalston, Rutland, Sterling, Templeton, West Boylston, Westminster and Winchendon.

Health District No. 11. — Includes the city of Worcester, and the towns of Auburn, Brimfield, Brookfield, Charlton, Douglas, Dudley, Holland, Leicester, Millbury, Northbridge, North Brookfield, Oxford, Southbridge, Spencer, Sturbridge, Sutton, Uxbridge, Wales, Warren, Webster and West Brookfield.

Health District No. 12. — Includes the cities of Chicopee, Holyoke, and Springfield, and the towns of Agawam, Blandford, East Longmeadow, Enfield, Granby, Granville, Greenwich, Hampden, Huntington, Longmeadow, Ludlow, Monson, Montgomery, Palmer, Russell, South Hadley, Southwick, Tolland, Ware, West Springfield, Westfield and Wilbraham.

Health District No. 13. — Includes the city of Northampton, and the towns of Amherst, Ashfield, Belchertown, Bernardston, Buckland, Chesterfield, Colrain, Conway, Cummington, Deerfield, Easthampton, Erving, Gill, Goshen, Greenfield, Hadley, Hatfield, Leverett, Leyden, Montague, New Salem, Northfield, Orange, Pelham, Plainfield, Prescott, Shelburne, Shutesbury, Southampton, Sunderland, Warwick, Wendell, Westhampton, Whately and Williamsburg.

Health District No. 14. — Includes the cities of North Adams and Pittsfield, and the towns of Adams, Alford, Becket, Charlemont, Cheshire, Chester, Clarksburg, Dalton, Egremont, Florida, Great Barrington, Hancock, Hawley, Heath, Hinsdale, Lanesborough, Lee, Lenox, Middlefield, Monroe, Monterey, Mount Washington, New Ashford, New Marlborough, Otis, Peru, Richmond, Rowe, Sandisfield, Savoy, Sheffield, Stockbridge, Tyringham, Washington, West Stockbridge, Williamstown, Windsor and Worthington.

Cities and Towns alphabetically arranged.

Health District Number.	City or Town.	County.	Health District Number.	City or Town.	County.
3	Abington,	Plymouth.	10	Clinton,	Worcester.
9	Acton,	Middlesex.	3	Cohasset,	Norfolk.
1	Acushnet,	Bristol.	13	Colrain,	Franklin.
14	Adams,	Berkshire.	9	Concord,	Middlesex.
12	Agawam,	Hampden.	13	Conway,	Franklin.
14	Alford,	Berkshire.	13	Cummington,	Hampshire.
8	Amesbury,	Essex.			
13	Amherst,	Hampshire.	14	Dalton,	Berkshire.
8	Andover,	Essex.	10	Dana,	Worcester.
5	Arlington,	Middlesex.	7	Danvers,	Essex.
10	Ashburnham,	Worcester.	1	Dartmouth,	Bristol.
10	Ashby,	Middlesex.	2	Dedham,	Norfolk.
13	Ashfield,	Franklin.	13	Deerfield,	Franklin.
6	Ashland,	Middlesex.	1	Dennis,	Barnstable.
10	Athol,	Worcester.	2	Dighton,	Bristol.
2	Attleborough,	Bristol.	11	Douglas,	Worcester.
11	Auburn,	Worcester.	6	Dover,	Norfolk.
2	Avon,	Norfolk.	9	Dracut,	Middlesex.
9	Ayer,	Middlesex.	11	Dudley,	Worcester.
			9	Dunstable,	Middlesex.
1	Barnstable,	Barnstable.	3	Duxbury,	Plymouth.
10	Barre,	Worcester.			
14	Becket,	Berkshire.	3	East Bridgewater,	Plymouth.
9	Bedford,	Middlesex.	12	East Longmeadow,	Hampden.
13	Belchertown,	Hampshire.	1	Eastham,	Barnstable.
2	Bellingham,	Norfolk.	13	Easthampton,	Hampshire.
5	Belmont,	Middlesex.	2	Easton,	Bristol.
2	Berkley,	Bristol.	1	Edgartown,	Dukes.
10	Berlin,	Worcester.	14	Egremont,	Berkshire.
13	Bernardston,	Franklin.	12	Enfield,	Hampshire.
7	BEVERLY,	Essex.	13	Erving,	Franklin.
9	Billerica,	Middlesex.	7	Essex,	Essex.
2	Blackstone,	Worcester.	5	EVERETT,	Middlesex.
12	Blandford,	Hampden.			
10	Bolton,	Worcester.	1	Fairhaven,	Bristol.
4	BOSTON,	Suffolk.	1	FALL RIVER,	Bristol.
1	Bourne,	Barnstable.	1	Falmouth,	Barnstable.
9	Boxborough,	Middlesex.	10	FITCHBURG,	Worcester.
8	Boxford,	Essex.	14	Florida,	Berkshire.
10	Boylston,	Worcester.	2	Foxborough,	Norfolk.
2	Braintree,	Norfolk.	6	Framingham,	Middlesex.
1	Brewster,	Barnstable.	2	Franklin,	Norfolk.
3	Bridgewater,	Plymouth.	1	Freetown,	Bristol.
11	Brimfield,	Hampden.			
3	BROCKTON,	Plymouth.	10	Gardner,	Worcester.
11	Brookfield,	Worcester.	1	Gay Head,	Dukes.
6	Brookline,	Norfolk.	8	Georgetown,	Essex.
13	Buckland,	Franklin.	13	Gill,	Franklin.
9	Burlington,	Middlesex.	7	GLOUCESTER,	Essex.
			13	Goshen,	Hampshire.
5	CAMBRIDGE,	Middlesex.	1	Gosnold,	Dukes.
2	Canton,	Norfolk.	6	Grafton,	Worcester.
9	Carlisle,	Middlesex.	12	Granby,	Hampshire.
3	Carver,	Plymouth.	12	Granville,	Hampden.
14	Charlemont,	Franklin.	14	Great Barrington,	Berkshire.
11	Charlton,	Worcester.	13	Greenfield,	Franklin.
1	Chatham,	Barnstable.	12	Greenwich,	Hampshire.
9	Chelmsford,	Middlesex.	9	Groton,	Middlesex.
4	CHELSEA,	Suffolk.	8	Groveland,	Essex.
14	Cheshire,	Berkshire.			
14	Chester,	Hampden.	13	Hadley,	Hampshire.
13	Chesterfield,	Hampshire.	3	Halifax,	Plymouth.
12	CHICOPEE,	Hampden.	7	Hamilton,	Essex.
1	Chilmark,	Dukes.	12	Hampden,	Hampden.
14	Clarksburg,	Berkshire.	14	Hancock,	Berkshire.

Cities and Towns alphabetically arranged — Continued.

Health District Number.	City or Town.	County.
3	Hanover,	Plymouth.
3	Hanson,	Plymouth.
10	Hardwick,	Worcester.
9	Harvard,	Worcester.
1	Harwich,	Barnstable.
13	Hatfield,	Hampshire.
8	HAVERHILL,	Essex.
14	Hawley,	Franklin.
14	Heath,	Franklin.
3	Hingham,	Plymouth.
14	Hinsdale,	Berkshire.
2	Holbrook,	Norfolk.
10	Holden,	Worcester.
11	Holland,	Hampden.
6	Holliston,	Middlesex.
12	HOLYOKE,	Hampden.
6	Hopedale,	Worcester.
6	Hopkinton,	Middlesex.
10	Hubbardston,	Worcester.
10	Hudson,	Middlesex.
3	Hull,	Plymouth.
12	Huntington,	Hampshire.
2	Hyde Park,	Norfolk.
7	Ipswich,	Essex.
3	Kingston,	Plymouth.
3	Lakeville,	Plymouth.
10	Lancaster,	Worcester.
14	Lanesborough,	Berkshire.
8	LAWRENCE,	Essex.
14	Lee,	Berkshire.
11	Leicester,	Worcester.
14	Lenox,	Berkshire.
10	Leominster,	Worcester.
13	Leverett,	Franklin.
9	Lexington,	Middlesex.
13	Leyden,	Franklin.
9	Lincoln,	Middlesex.
9	Littleton,	Middlesex.
12	Longmeadow,	Hampden.
9	LOWELL,	Middlesex.
12	Ludlow,	Hampden.
10	Lunenburg,	Worcester.
7	LYNN,	Essex.
7	Lynnfield,	Essex.
5	MALDEN,	Middlesex.
7	Manchester,	Essex.
2	Mansfield,	Bristol.
7	Marblehead,	Essex.
1	Marion,	Plymouth.
6	MARLBOROUGH,	Middlesex.
3	Marshfield,	Plymouth.
1	Mashpee,	Barnstable.
1	Mattapoisett,	Plymouth.
9	Maynard,	Middlesex.
6	Medfield,	Norfolk.
5	MEDFORD,	Middlesex.
6	Medway,	Norfolk.
5	MELROSE,	Middlesex.
6	Mendon,	Worcester.
8	Merrimac,	Essex.
8	Methuen,	Essex.
3	Middleborough,	Plymouth.
14	Middlefield,	Hampshire.
7	Middleton,	Essex.
6	Milford,	Worcester.
11	Millbury,	Worcester.
6	Millis,	Norfolk.
2	Milton,	Norfolk.
14	Monroe,	Franklin.
12	Monson,	Hampden.
13	Montague,	Franklin.
14	Monterey,	Berkshire.
12	Montgomery,	Hampden.
14	Mount Washington,	Berkshire.
7	Nahant,	Essex.
1	Nantucket,	Nantucket.
6	Natick,	Middlesex.
6	Needham,	Norfolk.
14	New Ashford,	Berkshire.
1	NEW BEDFORD,	Bristol.
10	New Braintree,	Worcester.
14	New Marlborough,	Berkshire.
13	New Salem,	Franklin.
8	Newbury,	Essex.
8	NEWBURYPORT,	Essex.
6	NEWTON,	Middlesex.
2	Norfolk,	Norfolk.
14	NORTH ADAMS,	Berkshire.
8	North Andover,	Essex.
2	North Attleborough,	Bristol.
11	North Brookfield,	Worcester.
5	North Reading,	Middlesex.
13	NORTHAMPTON,	Hampshire.
6	Northborough,	Worcester.
11	Northbridge,	Worcester.
13	Northfield,	Franklin.
2	Norton,	Bristol.
3	Norwell,	Plymouth.
2	Norwood,	Norfolk.
1	Oak Bluffs,	Dukes.
10	Oakham,	Worcester.
13	Orange,	Franklin.
1	Orleans,	Barnstable.
14	Otis,	Berkshire.
11	Oxford,	Worcester.
12	Palmer,	Hampden.
10	Paxton,	Worcester.
7	Peabody,	Essex.
13	Pelham,	Hampshire.
3	Pembroke,	Plymouth.
9	Pepperell,	Middlesex.
14	Peru,	Berkshire.
10	Petersham,	Worcester.
10	Phillipston,	Worcester.
14	PITTSFIELD,	Berkshire.
13	Plainfield,	Hampshire.
2	Plainville,	Norfolk.
3	Plymouth,	Plymouth.
3	Plympton,	Plymouth.
13	Prescott,	Hampshire.
10	Princeton,	Worcester.
1	Provincetown,	Barnstable.
2	QUINCY,	Norfolk.
2	Randolph,	Norfolk.
2	Raynham,	Bristol.
5	Reading,	Middlesex.
2	Rehoboth,	Bristol.
4	Revere,	Suffolk.
14	Richmond,	Berkshire.
1	Rochester,	Plymouth.
3	Rockland,	Plymouth.
7	Rockport,	Essex.
14	Rowe,	Franklin.

Cities and Towns alphabetically arranged—Concluded.

Health District Number.	City or Town.	County.	Health District Number.	City or Town.	County.
8	Rowley,	Essex.	6	Upton,	Worcester.
10	Royalston,	Worcester.	11	Uxbridge,	Worcester.
12	Russell,	Hampden.			
10	Rutland,	Worcester.	5	Wakefield,	Middlesex.
			11	Wales,	Hampden.
7	SALEM,	Essex.	2	Walpole,	Norfolk.
8	Salisbury,	Essex.	5	WALTHAM,	Middlesex.
14	Sandisfield,	Berkshire.	12	Ware,	Hampshire.
1	Sandwich,	Barnstable.	1	Wareham,	Plymouth.
7	Saugus,	Essex.	11	Warren,	Worcester.
14	Savoy,	Berkshire.	13	Warwick,	Franklin.
3	Scituate,	Plymouth.	14	Washington,	Berkshire.
2	Seekonk,	Bristol.	5	Watertown,	Middlesex.
2	Sharon,	Norfolk.	6	Wayland,	Middlesex.
14	Sheffield,	Berkshire.	11	Webster,	Worcester.
13	Shelburne,	Franklin.	6	Wellesley,	Norfolk.
6	Sherborn,	Middlesex.	1	Wellfleet,	Barnstable.
9	Shirley,	Middlesex.	13	Wendell,	Franklin.
6	Shrewsbury,	Worcester.	7	Wenham,	Essex.
13	Shutesbury,	Franklin.	10	West Boylston,	Worcester.
1	Somerset,	Bristol.	3	West Bridgewater,	Plymouth.
5	SOMERVILLE,	Middlesex.	11	West Brookfield,	Worcester.
12	South Hadley,	Hampshire.	8	West Newbury,	Essex.
13	Southampton,	Hampshire.	12	West Springfield,	Hampden.
6	Southborough,	Worcester.	14	West Stockbridge,	Berkshire.
11	Southbridge,	Worcester.	1	West Tisbury,	Dukes.
12	Southwick,	Hampden.	6	Westborough,	Worcester.
11	Spencer,	Worcester.	12	Westfield,	Hampden.
12	SPRINGFIELD,	Hampden.	9	Westford,	Middlesex.
10	Sterling,	Worcester.	13	Westhampton,	Hampshire.
14	Stockbridge,	Berkshire.	10	Westminster,	Worcester.
5	Stoneham,	Middlesex.	6	Weston,	Middlesex.
2	Stoughton,	Norfolk.	1	Westport,	Bristol.
9	Stow,	Middlesex.	2	Westwood,	Norfolk.
11	Sturbridge,	Worcester.	3	Weymouth,	Norfolk.
6	Sudbury,	Middlesex.	13	Whately,	Franklin.
13	Sunderland,	Franklin.	3	Whitman,	Plymouth,
11	Sutton,	Worcester.	12	Wilbraham,	Hampden,
7	Swampscott,	Essex.	13	Williamsburg,	Hampshire.
1	Swansea,	Bristol.	14	Williamstown,	Berkshire.
			9	Wilmington,	Middlesex.
2	TAUNTON,	Bristol.	10	Winchendon,	Worcester.
10	Templeton,	Worcester.	9	Winchester,	Middlesex.
9	Tewksbury,	Middlesex.	14	Windsor,	Berkshire.
1	Tisbury,	Dukes.	4	Winthrop,	Suffolk.
12	Tolland,	Hampden.	9	WOBURN,	Middlesex.
7	Topsfield,	Essex.	11	WORCESTER,	Worcester.
9	Townsend,	Middlesex.	14	Worthington,	Hampshire.
1	Truro,	Barnstable.	2	Wrentham,	Norfolk.
9	Tyngsborough,	Middlesex.			
14	Tyringham,	Berkshire.	1	Yarmouth,	Barnstable.

THE STATE INSPECTORS OF HEALTH.

District No. 1.—Dr. ADAM S. MACKNIGHT, Fall River.
District No. 2.—Dr. ELLIOTT WASHBURN, Taunton.
District No. 3.—Dr. WALLACE C. KEITH, Brockton.
District No. 4.—Dr. HARRY LINENTHAL, Boston.
District No. 5.—Dr. FRANK L. MORSE, Somerville.
District No. 6.—Dr. WM. W. WALCOTT, Natick.
District No. 7.—Dr. J. WM. VOSS, Beverly.
District No. 8.—Dr. WM. HALL COON, Haverhill.

District No. 9. — Dr. CHARLES E. SIMPSON, Lowell.
District No. 10. — Dr. LEWIS FISH, Fitchburg.
District No. 11. — Dr. MELVIN G. OVERLOCK, Worcester.
District No. 12. — Dr. JAMES V. W. BOYD, Springfield.
District No. 13. — Dr. JOHN S. HITCHCOCK, Northampton.
District No. 14. — Dr. LYMAN A. JONES, North Adams.

OUTLINE OF THE POWERS AND DUTIES OF THE STATE INSPECTORS OF HEALTH.

I. Advisory Authority.

1. Inquiry and Action concerning Influences and Diseases that are or may be Dangerous to the Public Health.

The State Inspectors of Health are authorized to gather all information possible concerning all influences that are or may be dangerous to the public health and concerning the prevalence of tuberculosis and other communicable diseases. They disseminate knowledge as to the best methods of preventing the spread of diseases dangerous to the public health, and take such steps as, after consulting with the State Board of Health and the local health authorities, are deemed advisable for their eradication.

2. Dealings with Local Health Authorities as to: —

A. Rules and Regulations.

The State Inspectors of Health have been of considerable assistance to local health authorities in aiding them draft rules and regulations; and as the work of the local authorities is gradually placed on a higher plane, the men can be of even greater assistance, under the guidance of the State Board of Health, in obtaining uniformity in health work throughout the State.

B. Diseases Dangerous to the Public Health.

The State Inspectors of Health: —

(*a*) Consult with the local health authorities as to the best methods of preventing the spread of diseases dangerous to the public health.

(*b*) Advise the local authorities to urge physicians to report any known case of such a disease and to see that the notification laws are enforced.

(*c*) Investigate and report to local boards of health any known cases of ophthalmia neonatorum, so that the law requiring local boards of health "to take such immediate action as they may deem necessary in order that blindness may be prevented" may be enforced.

(*d*) Assist the local authorities as to the manner of caring for persons found ill in a neglected condition with such disease.

(*e*) Advise and assist local authorities in the enforcement of quarantine.

(*f*) Report to the State Board of Health and the proper local health authority every communicable disease discovered in a tenement workshop.

(*g*) Notify the State Board of Health and the proper local health authority of the existence of any such disease in factories and workshops.

C. Nuisances and Causes of Sickness.

In the work of abating nuisances the State Inspectors of Health advise local authorities as to the prevention of conditions which are dangerous to health, or which are offensive to the senses and render habitations uncomfortable.

D. Sanitation of Tenement Homes.

The State Inspectors of Health have been of considerable assistance to the local authorities in dealing with the problem of the sanitation of tenement homes. A high standard of sanitation in factories, brought about largely by rigid inspection, should go hand in hand with improved home conditions, particularly the tenement homes.

E. Statistics.

Efforts have been made to bring about uniformity in recording statistics relating to health work of all kinds.

3. Inquiry concerning the Health of Minors employed in Factories.

The work of obtaining information concerning the health of minors employed in factories calls for a knowledge of the ill health or physical unfitness of the minors. It involves obtaining personal and family histories, recording observations, and, in a considerable proportion of cases, making physical examinations.

4. Sanitation of School Buildings.

The law requires the State Inspectors of Health to make such examinations of school buildings as in the opinion of the State Board of Health the protection of the health of the pupils may require.

5. Matters relating to Water Supply and Sewerage.

The State Inspectors of Health, by intelligent co-operation, assist the State Board of Health materially in forwarding the work of the water supply and sewerage department. The law provides for adequate supply of pure drinking water for factory employees, and for proper disposal of sewage from factories and foundries.

II. Executive Authority.

1. Sanitation of Factories, Workshops and Other Industrial Establishments.

The work relating to the sanitation of factories, workshops and other industrial establishments includes the enforcement of certain laws. It also includes the study of the effect of occupation upon the health of persons employed in such establishments.

2. Exclusion of Minors from Occupations deemed to be Injurious to Health.

In the enforcement of the law which provides for the exclusion of minors from occupations or processes deemed by the State Board of Health to be injurious to health, the State Inspectors of Health consider carefully the varying conditions associated with a given occupation or process, as well as the condition of health of each minor at work.

3. Sanitation of Tenements where Clothing is made.

The primary object of inspection of tenement workrooms is to guard the public health from the spread of contagious diseases by means of infected wearing apparel. The work accomplished has resulted in the maintenance of higher sanitary standards in the congested tenement homes. Moreover, the friendly visits to the homes and the close personal contact with the workers have been a great educational force in the development of higher standards of hygienic living.

4. Inspection of Mercantile Establishments.

Inspection of mercantile establishments is made (*a*) to determine whether a sufficient number of seats are provided for women employees and whether there are proper toilet rooms for both sexes in such establishments, and (*b*) to enforce the statute provisions relating thereto.

5. Sanitation of Stationhouses.

In accordance with the law providing for an examination of the sanitary conditions in stationhouses, houses of detention and lock-ups in the Commonwealth, the State Inspectors of Health consider the ventilation, lighting, heating, construction of cells, care and use of bedding and dishes used for food, method of sewage disposal, and method of supplying drinking water to prisoners in all such buildings.

6. Sanitation of Slaughterhouses.

Under the existing laws all slaughterhouses are subject to inspection by the State Inspectors of Health.

DISEASES DANGEROUS TO THE PUBLIC HEALTH.

The work relating to the prevention of the spread of diseases dangerous to the public health constitutes the *most important of all the duties* of the State Inspectors of Health. This work involves obtaining information respecting the sanitary condition of the Commonwealth and concerning all influences and diseases that are or may be dangerous to the public health. While the area of the Commonwealth in comparison with that of almost all other States of the Union is small, the fourteen health districts together include thirty-three incorporated cities and three hundred and twenty-one towns. This means that each district contains a considerable population, and that each State Inspector of Health must keep in touch with all of the local health authorities within his district, watch the incidence of communicable diseases in each city and town, inquire into their causes, circulate general information among the people as to the best methods of preventing their spread, and be prepared to suggest preventive measures to the local authorities, and to "take such steps as, after consultation with the State Board of Health and the local health authorities, shall be deemed advisable for their eradication."

In short, the authority given by the Legislature to the State Inspectors of Health for taking steps to prevent the spread of infectious diseases is limited only by the many specific provisions which require much of the inspectors' time, and by the amount of money appropriated for their entire work. The investigation of the *prevalence of tuberculosis,* and of the methods to prevent the spread of this disease, is itself a task of considerable magnitude and of great importance to the community. In all of this work there is but one object in view, viz., to guard the public health. The State Inspectors of Health, by virtue of their position, appeal to the medical profession on the one hand and to the laity on the other, teaching all that the promotion of public health is a matter which concerns not only the medical profession but every profession and every individual.

NOTIFICATION OF INFECTIOUS DISEASES DANGEROUS TO THE PUBLIC HEALTH.

List of the Diseases. Duties of Householders, Physicians, Local Health Authorities, the State Board of Health and the State Inspectors of Health.

The infectious diseases which are kept constantly under the eyes of all health officials are those which the State Board of Health, by authority of the Legislature, have declared to be "*dangerous to the public health,*" and therefore notifiable under the provisions of sections 49 and 50 of chapter 75 of the Revised Laws. Following are the diseases thus declared to be dangerous to the public health: —

Anterior poliomyelitis.
Actinomycosis.
Asiatic cholera.
Cerebro-spinal meningitis.
Diphtheria.
Glanders.
Leprosy.
Malignant pustule.
Measles.
Ophthalmia neonatorum.
Scarlet fever.
Smallpox.
Tetanus.
Trachoma.
Trichinosis.
Tuberculosis.
Typhoid fever.
Typhus fever.
Varicella.
Whooping cough.
Yellow fever.

If a householder knows that a person in his family is sick with a disease dangerous to the public health, he is expected to notify at once the board of health of the city or town in which he lives. If a physician knows that a person whom he is called to visit has a disease dangerous to the public health, he must give immediate notice to the local board of health. If a local board of health has had notice of or discovers a disease dangerous to the public health, it is required to notify (in writing) the State Board of Health within twenty-four hours, giving the name and the location of the patient. In order that each State Inspector of Health may be as promptly informed of the existence of such a disease within his district, the State Board of Health supplies for the use of the local boards of health a double postal card, — one card to be sent to a State Inspector of Health and the other to the office of the State Board of Health. By this means it is now possible for the State Board of Health, through the State Inspectors of Health, to follow the incidence of the diseases declared by law to be dangerous to the public health, in order to inquire into the causes of the diseases and to suggest practical measures to prevent their spread.

The local boards of health, in consequence of being in closer touch with each individual member of the community, are given a large measure of discretion in the matter of preventing, by all means in their power, the spread of a dangerous disease whenever and wherever it is known to exist. Acting in accordance with the general State laws they make ordinances and rules for the protection of the public health. The methods which they employ are first, *notification;* second, *isolation or quarantine;* and third, *disinfection and removal from quarantine.* To this may be added, for the purpose of securing immunity from certain diseases, the provision by the State Board of Health of *vaccine* as a protection against smallpox, of *antitoxin* for securing immunity against diphtheria, and the provision of a *prophylactic of nitrate of silver solution* in cases of ophthalmia neonatorum, for the prevention of blindness.

Notification of the Community of the Existence of Infection.

If an infectious disease, declared by the State Board of Health to be dangerous to the public health, exists in a town the selectmen and board of health are required by law to give public notice of infected places by any means which in their judgment may be most effectual for the common safety. Investigation has disclosed the fact that every city and town in the Commonwealth is accustomed to give notice of the existence of some of the diseases by posting a placard on the house or by displaying a red flag. In a certain number of communities in the State it is customary to display a red flag, in others to placard houses, for smallpox. Nearly every community placards houses for scarlet fever and diphtheria. In some — more than a third — of the towns and cities it was found to be the custom to placard houses for measles. In the event of typhoid fever it appears that only 35 towns or cities are accustomed to placard houses to prevent the spread of this disease; whereas it is the custom for 7 cities and 11 towns to placard houses to prevent the spread of cerebrospinal meningitis.

Isolation or Quarantine. Isolation Hospitals.

The Legislature has given to the local boards of health extraordinary power in the matter of isolating or quarantining from the community at large persons ill with infectious diseases which are or may be dangerous to the public health. It is the duty of local boards to prevent by all means within their power the spread of infection, and the Legislature has not seen fit to prescribe what measures shall be taken. It is now commonly the practice to require the isolation, either in their own dwellings or in hospitals provided for the purpose, of persons suffering with communicable diseases, including smallpox, diphtheria, scarlet fever, tuberculosis, typhoid fever, infantile paralysis; and also the exclusion from school of scholars ill with such diseases and of other scholars living in the same household with pupils so suffering. Isolation is applied to certain other infectious diseases, such as measles, whooping cough, chicken pox, in a less rigid manner.

In 193 towns and 22 cities quarantine is established and inspected when it is deemed necessary by the local board of health. In 21 towns and 4 cities quarantine is established and inspected only occasionally, or on complaint, by the local board of health. In 107 towns and 7 cities there is practically no inspection of quarantine, if established, by the local board.

While the practice of providing special hospitals for the isolation of persons ill with such infectious diseases as smallpox, scarlet fever and diphtheria has existed to a greater or less extent for some years, only in recent years has there become a general awakening as to the need of a similar provision for the treatment of persons ill with tuberculosis. The State Inspectors of Health frequently aid in the removal to the State sanatoria of certain persons ill with tuberculosis and endangering the public health, and urge upon local authorities the need of establishing day camps, and hospitals for the care of persons in an advanced stage of the disease and others who cannot be admitted to the State institutions.

The State sanatoria at Rutland, North Reading, Lakeville and Westfield send notification to the State Inspectors of Health of the addresses of tuberculous patients recently admitted, so that in every instance the inspectors can see to it that the local board of health is notified, and shall clean and disinfect the premises recently vacated by the patient, or otherwise protect new tenants against the danger of infection.

The State Inspectors of Health, from their knowledge and experience in factory conditions, are, if legal provision were made, in a position to accomplish still more good if they were required to keep a record of the dwelling place, occupation and physical condition of all persons in their respective districts who have been inmates of the State sanatoria, and from time to time forward to each State sanatorium a report of the condition of the persons who have been treated therein. By thus following the occupation of such persons greater protection would be given to the other employees, especially to minors, who, owing to the nature of their work, frequently mingle with adults in various parts of a factory.

Disinfection and Removal from Quarantine.

Statistical information gathered concerning the methods employed for disinfection, and their effectiveness, shows great diversity. While such information tends to prove that immunity from recurrent cases does not come from the practice of room disinfection, the real value of effective room disinfection cannot be known until more uniformity of method and practice exists than at the present time. Authorities may differ as to the value of chemical disinfectants, but there can be no question that the unscientific use of otherwise serviceable chemical disinfectants and the employment of worthless agents should be abandoned at once. The present careless use of chemical disinfectants for room disinfection gives a false sense of security to the community. *Chemical disinfectants* do not remove dirt and cannot take the place of cleaning. Such agents, therefore, should be applied after cleaning, but not in place of cleaning. After all articles of the infected, including the patient's clothing and suspected bedding, have been removed and properly cared for by boiling, steam disinfection or such other procedures as modern knowledge deems to be necessary, the first thing in importance is to cleanse the room or rooms occupied by the patient. Thorough cleansing of the room, including free ventilation and if possible the admission of light and sunshine, is essential for effective disinfection. The room, including walls, ceiling, fittings and floor, and all articles of furniture, should be cleansed by scrubbing with soap and hot water, and wherever practicable with a hot solution of washing soda. During later years the use of formaldehyde by means of various forms of apparatus has very largely superseded the use of other chemical disinfectants.

Release from Quarantine.

In only 29 towns and 8 cities has it been the practice to release patients from quarantine following disinfection solely upon the report of the physician or agent of the local board of health. In other towns and cities it has been the custom, to a greater or less extent, to release patients upon the report of the attending physicians.

Cultures for Release from Diphtheria Quarantine.

Careful investigation by the State Inspectors of Health disclosed the fact that 146 towns and 30 cities, with a total population of 2,849,000, required one or more negative cultures for releasing from quarantine patients ill with diphtheria. Ten other communities, including 1 city, with a population of 41,350, sometimes required one or more negative cultures. One hundred and sixty-eight communities, including 2 cities, with a population of 365,365, did not require a negative culture for the release of persons ill with this disease. In other words, practically 88 per cent. of the population of the State was protected against the spread of diphtheria by the use of negative cultures, while less than 12 per cent. of the population was without the protection to be secured by this means.

During the period of inquiry, ending June, 1910, many changes occurred in the requirements of the local boards of health. A considerable number of towns which had no requirement whatever speedily adopted some requirement; while, on the other hand, some of the towns which had very strict regulations so altered them as to afford little, if any, protection to the community. In 47 communities the requirements were in some instances increased from "none" or "when needed" to one or two cultures, and in others from one to two. On the other hand, in 32 communities the requirements were relaxed, in some instances from the use of three to two or one negative cultures, and in others from one to "none," or "leaving the matter to the attending physician."

In those towns and cities which required two negative cultures before releasing the diphtheria patient from quarantine, 7, including 6 cities, required an interval of twenty-four hours before taking the second culture.

That such changes should constantly occur in the absence of any fixed requirement by the State is not to be wondered at in view of the frequent changes in the local health boards, especially in the smaller towns. Personal interest on the part of health officers who desire to save the town expense, or, in case they are practising physicians, to favor their patients, or the lack of laboratory facilities near at hand, are some of the factors which contribute to bring about the relaxation of the requirements. It should be mentioned, however, that many of the towns which require no release culture are small, with a widely scattered population and infrequent cases of diphtheria, so that the question seldom comes up for consideration.

Vaccination.

As a rule, vaccination is enforced in most of the cities and larger towns of the Commonwealth. It is strictly enforced in 30 cities and 210 towns. It is or has been indifferently or irregularly enforced in 3 cities and 41 towns. It has not been enforced in 70 towns.

TUBERCULOSIS.

The work carried on by the State Inspectors of Health relative to tuberculosis varied greatly, according to the special problems presented in the different districts, and was limited by the amount of time the inspectors could give to it in view of the limited appropriation and the numerous powers and duties conferred and imposed upon them by the Legislature. In spite of the statute limitation, however, much has been accomplished along the following lines.

Numerous conferences were held with local boards of health and physicians, and advice given as to the reporting of cases, the care of neglected patients, the establishment of quarantine, and the disinfection of premises after the removal or death of persons ill with the disease. Moreover, literature was distributed relative to the prevention of the spread of the disease.

The need of hospitals for the care of persons ill with tuberculosis and endangering the public health was brought to the attention of the local authorities in certain cities.

Detailed investigations were made in some districts of housing conditions and their relation to the prevalence of the disease; also as to the prevalence of the disease among the foreign population in certain cities.

In connection with the work of enforcing the laws relative to the sanitation of industrial establishments, investigations were made as to the prevalence of tuberculosis in certain industries. This investigation was handicapped, however, by the lack of authority of the State Inspectors of Health to inform themselves concerning the health of the adult operatives. Such authority is necessary to protect the health of the adults as well as of the minors employed in industrial establishments.

Examinations were made of many minors, and, by permission, of some adults, and those found tubercular were referred to local boards of health and other agencies.

As a result of their investigations the State Inspectors of Health pointed out that unorganized and haphazard work in tuberculosis was of little value. To render the work effective there must be a close co-operation between all agencies who deal with the prevention of the disease.

In connection with tenement workrooms it was shown that the provisions of the law regulating tenement workrooms should be extended to articles other than wearing apparel which may act as factors in the dissemination of the disease.

A brief summary of the work of the State Inspectors of Health in dealing with tuberculosis follows: —

Many persons with tuberculosis applied to the State Inspector of Health of South Bristol County. Examinations were made almost daily of suspected cases referred to him by private physicians or social workers. The cases found ill with the disease were referred to the local board of health or to a local anti-tuberculosis society. An investigation of the prevalence of tuberculosis in the district showed that the largest percentage of the cases was found in Fall River, 269; and that the next largest was found in New Bedford, 206.

In this district on account of the various nationalities which compose the population, more particularly of New Bedford and Fall River, the problems presented relative to tuberculosis were often very difficult. The foreign population of these cities live in congested districts under unsanitary conditions. Many tenements were found from which cases of tuberculosis were frequently reported. In all such cases investigations were made to determine whether the premises were properly disinfected.

The State Inspector of Health of south Norfolk and north Bristol counties, after an extended study as to the prevalence of the spread of tuberculosis in his district, reported that trustworthy conclusions as to the exact morbidity of the disease could not be drawn from the number of cases reported to the local boards of health. Much time was spent in obtaining data in regard to the spread of tuberculosis among employees in more than one hundred jewelry factories. The State Inspector of Health was handicapped in the investigation, however, because of lack of authority in informing himself concerning the health of the adult operatives. The inspector found that many cases of tuberculosis were not reported to the health authorities, and that a considerable number of the sick had no physician.

The attention of the boards of health of Suffolk County was called to the premises vacated by tubercular patients who had either moved or entered private sanatoria, and recommendations were made in each instance that such premises be disinfected.

The Chelsea board of health started an active campaign to prevent the spread of the disease. A free clinic was started for the examination and treatment of cases, and by arrangement with the District Nursing Association a district nurse visited the cases at their homes. In some factories educational leaflets were put in the pay envelopes of the operatives. A school tuberculosis exhibit was purchased for use in the schools, and the board of health consulted with the school department with a view to carrying out more effectively the law requiring instruction in tuberculosis in the public schools.

During 1910, 273 cases of tuberculosis were reported to the towns and cities of the southern Essex County district. In the city of Lynn the State Inspector of Health visited the homes of 80 persons who were alleged to be ill with this disease, in order to inform himself concerning the conditions under which the people lived, and to give instructions regarding the promotion of personal and public health. The inspector advised the city authorities to erect a hospital for the care of those persons who were found to be seriously ill with the disease, but notwithstanding the efforts of the local board of health such a course of action has not yet been taken.

The State Inspector of Health of the north Middlesex County district reported that the disease was not well reported in the larger towns outside of Lowell. In Lowell the cases appeared to be better reported than during previous years. The physicians were aided in reporting their cases by the local laboratory, which examined sputum for diagnosis. During 1909, 154 cases of pulmonary tuberculosis were reported and 33 cases of other forms of the disease. The physicians submitted to the laboratory, for diagnosis, 467 specimens of sputum, 306 of which were negative and 161 positive. As the assertion was pretty generally made that a very large proportion of Greeks were tuberculous (from 25 per cent. to 60 per cent.) an investigation of the hospital records was made to get some light on the subject. Of 258 Greeks admitted to the Lowell Hospital in one year, 26, or about 10 per cent., were found to be registered for some form of tuberculosis. The percentage of pulmonary cases was 1½ per cent. more than the average for all cases treated. In looking over a list of deaths from tuberculosis, and the residence of the patients, it was discovered that a large number of persons were found to have died at the same street and number, some of the same family name, showing by the dates that one had taken the disease from another. Many were found at the same number with different names, thus giving rise to the question whether the persons may have contracted the disease from the bacilli left in the house by former patients. Three cases of the disease were carefully studied and considered to result from contact in one house.

In all the smaller towns within the north Worcester County district the State Inspector of Health urged the local health authorities to disinfect homes after death or removal.

The town of Athol was very slow to report cases of tuberculosis until the matter was several times taken up by the health inspector with a new medical member of the board. During the years 1907–09, inclusive, 28 deaths from tuberculosis were recorded, although it was very rare that a case was reported to the local board of health. Until some time during the year 1910 there had been no cleaning and disinfecting of homes after deaths from tuberculosis, or following removal of the patients.

Little was done in Leominster regarding the control of the prevention of the spread of tuberculosis, except that the board of health has insisted upon cases being reported by physicians, has disinfected premises after death or removal, and has assumed the expense of care for several in institutions.

Few cases of tuberculosis were reported in Winchendon during 1909. The local board of health now disinfects premises after death or removal.

A thorough investigation was made of the prevalence of tuberculosis in Clinton during a period of five years from 1905–09. The number of cases reported and the number of deaths from the disease for each year were examined, and wherever possible the occupation of the patients was determined. An investigation was made to determine what conditions existed in this community which tended to spread the disease.

The general sanitary conditions of the town were quite satisfactory. Conditions had greatly improved since the construction of the metropolitan water basin. All the industrial establishments were visited and, in the main, showed satisfactory sanitary conditions. Moreover, the establishments were located on the borders of the town, so that a large number of the workers resided in sections of the town not thickly settled. The people were fairly well housed, — with the exception of a few instances the character of the buildings could not be considered to be an important factor in the spread of the disease. The domestic and personal habits of the people might, on the other hand, play an important role in the reducing of their physical resistance, hence be predisposing factors to the disease. During the investigation of the housing conditions, unventilated rooms, where means for ventilation were ample, overcrowding, uncleanliness of homes and persons, poor food and poor cooking were observed.

An active, intelligent campaign was carried on in the municipality to eradicate the disease. Under the supervision of a district nurse a camp was maintained, at which cases were cared for during the summer months. The local physicians gave their services to the camp when needed. During the winter months, when the camp was closed, the nurse followed up the cases in their homes.

The local tuberculosis league of Gardner was engaged in active work for the prevention, control and cure of tuberculosis. Harmony existed between the local board and the league, each co-operating with the other.

The local tuberculosis society of Fitchburg, with its visiting nurse and tuberculosis clinic, continued its valuable work in the prevention and cure of tuberculosis. The local board of health co-operated with these forces, and provided for the care of a large number of cases in various institutions. The local board conducted more efficient disinfection of the premises after death or removal of the patient.

In 1909, 106 cases, and in 1910, 126 cases of tuberculosis, mostly pulmonary, were reported to the Springfield board of health. Very little attention was paid by physicians in hospitals to reporting surgical and other forms of tuberculosis than pulmonary. The State Inspector of Health of the Hampden County district visited three of the larger hospitals, and found that in one there were 33 cases of surgical tuberculosis during 1910, none of which had been reported to the local board of health. Another hospital had 14 cases, and another 6, none of which had been reported. One surgeon stated that he had under treatment during the year 1910 approximately 60 cases of tuberculosis, none of which had been reported. The matter was taken up with the hospital and the local board of health, and the board issued circular letters to physicians in hospitals requesting that all forms of tuberculosis be reported. The State Inspector of Health reported the need of a hospital near Springfield for the care of chronic cases of the disease, on the ground that the prevalence of tuberculosis was not diminishing very rapidly.

The fact that tuberculosis was not well reported was clearly established by the State Inspector of Health of the Franklin and Hampshire counties district. In one city of this district a careful inquiry revealed the presence of 130 cases of all forms of the disease; only 64 of these had been reported to the local board of health. A comparison of the records of deaths from tuberculosis with those reported in that city showed that practically only those cases which terminated fatally were reported.

Considerable attention was devoted to tuberculosis in the Berkshire district. It was the subject of conversation with members of boards of health, with physicians and others. The importance of an early diagnosis and prompt report of cases was constantly insisted upon. Circulars of the State Board of Health on the "Prevention of the Spread of Tuberculosis" were sent to the homes of cases reported. An investigation of the prevalence of the disease in North Adams, Adams and Pittsfield indicated a further improvement as to reporting the cases in North Adams, with an apparent falling off in Adams and Pittsfield. The latter may possibly have been due, in part, to added cases reported the year before through the activities of the local tuberculosis societies, with fewer old cases presenting themselves the current year. Letters were written to 35 physicians in this district concerning cases of tuberculosis which they had failed to report, as shown by death returns signed by them where the cause of death was given as tuberculosis.

Progress in preventing the Spread of Tuberculosis.

By Wm. W. Walcott, M.D., State Inspector of Health.

It is a recognized fact that in addition to the well-organized forces — State, local and private — for combating the spread of tuberculosis, there are organizations and individuals with excellent intention who, on account of misdirected zeal, may do positive harm by their superficial work. It is this type of worker, for example, who is responsible for such signs in street cars and elsewhere as "Tuberculosis can be cured," as well as articles in newspapers and magazines which contain illustrations and give examples of the number of cases of the disease which have been cured by a few months' stay at some sanatorium, by a brief rest in the country or by sleeping out of doors. Such information may, to a certain extent, be truthful, but is it the whole truth? The question is a complicated one, with many conditions to be considered.

As the factory is such an important part of the community, especially the industrial community, let us consider what questions arise when we are dealing with and trying to help a factory employee with a history of tuberculosis or with present indications of the disease. In the first place, his exact physical condition must be noted, then his home conditions, and both studied from a sanitary and educational point of view. The possible influences of home conditions upon his health must be looked into, and proper instruction given to members of the household to prevent the spread of the disease. The next step is to make a careful study of the conditions under which the employee works not only the general sanitary conditions, but special factory conditions, involving one or more processes in connection with the work accomplished, as, for example, the study of the effects of exposure to poisonous and irritating dusts and fumes. Then follows such practical measures as the protection of the fellow workers in particular and the public in general from infection.

When it comes to treatment, whether home treatment is decided upon or out-of-door camp life or sanatoria treatment is immaterial, as compared with the results of such treatment. The State, some years ago, asked the question: How can the State best provide competent medical supervision for patients with tuberculosis? The answer was: To provide for such patients State sanatoria. But what happens to a person who, before entering a sanatorium, worked in a factory under certain conditions — perhaps for a period of years? What advice is given him on leaving the sanatorium apparently cured? How can we best keep in touch with him, and note, if any, the first signs of recurrence of the disease? In other words, how can we, by keeping in touch with the patient longer and by preventing a recurrence of the disease, promote more effectively the public health? These questions deserve special consideration, for while it is true that one may recover from tuberculosis, it is also true that the disease leaves "scars;" and after an attack one is, as a rule, not so strong as before, and must guard himself or be guarded against untoward influences. This means frequently a complete change in the mode of life for the persons in question, a fact which apparently is frequently overlooked or does not receive sufficient consideration. In the zeal to help new patients recurrences of the disease among the old cases are more frequent than they would be if some of the work were done more thoroughly and the patients followed for a longer time. As the tuberculosis work is progressing at present, the State Inspectors of Health could doubtless take even a larger part in it than they have in the past, for they have become particularly well fitted to answer the questions that must be considered when dealing with tubercular operatives. In the first place, their knowledge of occupational hygiene in their own health districts assists them in determining the influence of factory conditions or industrial processes upon the health of any given individual. In the second place, the investigation of diseases, other than tuberculosis, dangerous to the public health in a community brings these physicians in touch not only with the persons in the factory, but, through the local health authorities, with those in the home. Finally, the co-operation of these physicians, under the direction of the State Board of Health, with the Trustees of Hospitals for Consumptives has given them experience of considerable value. If the inspectors could keep themselves informed concerning the occupation of the partially cured tubercular operatives, not only would such persons be better cared for and the results of a more or less prolonged sanatorium treatment be known, but greater protection would be given the other employees and the public at large.

In short, the State Inspectors of Health, by their knowledge of general health problems in the community, including the factory, the schoolhouse and the home, are in position not only to continue to co-operate with the forces doing efficient work in preventing the spread of tuberculosis, and to aid in the development of such work, but also to use their influence in such a way that only efficient work will be done.

Eighteen Cases of Tuberculosis among Children employed in Textile Factories.

By Wm. Hall Coon, M.D., State Inspector of Health.

Following are the facts concerning 18 children employed in textile establishments in my district who, on examination, were found to be ill with pulmonary tuberculosis: —

1. Male, fifteen years of age, "doffer." Sanitary conditions good. Found to live in a squalid tenement in the Italian quarter of the city. The family was finally prevailed upon to allow the boy to go into the country for some months. A decided improvement in his condition was noted later.

2. Female, fifteen years of age, repairs "harness" on loom. At work one year in department in which sanitary conditions were excellent. The girl then left her work and was placed under medical care. Assisted by the secretary of a local civic organization, she went into the country, and with proper care made marked improvement.

3. Female, sixteen years of age, "spinner." Worked under good sanitary conditions. Father died of tuberculosis. The girl was referred to Rutland, but refused to go. She left her work and placed herself under the care of a competent physician. Her health improved considerably under reasonably good home conditions.

4. Male, seventeen years of age, "storehouse helper." Worked under good sanitary conditions. The sanitary conditions in the home were good. The boy was removed from inside work, placed in the care of a competent physician, and was later given light, outdoor work. His health improved rapidly.

5. Female, fourteen years of age, "mender." Worked under excellent sanitary conditions. Home conditions distinctly bad. Suspicion of tuberculosis in the family. The girl was sent to the day camp of an anti-tuberculosis society, where she remained for some time, leaving in good health.

6. Male, fifteen years of age, "roving tender." At work three years, — part of the time in England. Family very poor. Suspicion of tuberculosis in the family. The boy was sent to a day camp in Lawrence, where a noticeable improvement was made in his physical condition. He later took up out-of-door work.

7. Female, sixteen years of age, "spooler." Worked under good sanitary conditions. The sanitary conditions in the home were distinctly bad. Although the parents objected to her leaving work, provision was finally made for treatment at the day camp of an anti-tuberculosis society. As the result of treatment her health was materially improved.

8. Female, fourteen years of age, "hander-in." Worked under good sanitary conditions. The sanitary conditions in the home were distinctly bad. Suspicion of tuberculosis in the family. She was sent to a day camp, where she made an improvement in health.

9. Male, fourteen years of age, "filling tender." Worked under good sani-

tary conditions. The sanitary conditions in the home were bad. Suspicion of tuberculosis in the family. Large family crowded in a small tenement. The boy went to a day camp for treatment, and returned much improved in health.

10. Female, seventeen years of age, "filling." Worked under good sanitary conditions. Suspicion of tuberculosis in family. Home surroundings distinctly bad. The girl went to a day camp, where she improved in health.

11. Female, fifteen years of age, "filling tender." Worked under good sanitary conditions. The sanitary conditions in the home were poor. She went to a day camp, where she made a decided improvement in health. She was seen later working in another mill and appeared to be in good health.

12. Male, fifteen years of age, "combing cotton." Worked under good sanitary conditions. The sanitary conditions in the home were bad. He went to a day camp and improved in health.

13. Male, sixteen years of age, "doffer." Worked under good sanitary conditions. The home surroundings were moderately bad. He was advised to go to a day camp, but left work and was lost sight of.

Each of 5 other minors employed in a cotton mill and found to show signs of beginning tuberculosis gave the following history: 3 of the minors were fourteen years of age, 1 fifteen and 1 seventeen. All were employed in the process of spinning, under good sanitary conditions, while in each instance the sanitary home conditions were bad.

Of 18 minors found with symptoms or signs of tuberculosis, 13 were found doing some kind of work which was associated with the process of spinning. The sanitary conditions in the homes of 12 of these 13 minors were found to be inferior to the sanitary conditions of the workrooms in which the minors were employed. The average age of the 18 minors was fifteen years and two months. There appeared to be no untoward influences associated with the employment of any of the minors found to have tuberculosis.

As has been stated, one important factor influencing the health of the minors is the unhygienic home conditions. Another factor frequently lost sight of, is the danger of infection through the adult workers, a considerable proportion of whom, if not already diseased, are predisposed, by health, habit and home surroundings, to tuberculosis. An examination of the records of the Lawrence board of health shows few cases of tuberculosis reported among mill employees under the age of twenty-one years. Adult employees may continue at work in the mill until positive ill health causes them to seek medical advice. In the meantime they have been the foci of infection for young persons about them. The average adult employee of a textile mill is closely confined at his work. In the two major departments of the textile industry — weaving and spinning — where men, women and minors are employed, the close attention to detail is required of the adult, with the corresponding confinement to the loom or frame used, so that little opportunity is given for the adult employee to move far from the machine which he operates; while, on the other hand, the minors who perform unskilled work are not confined to any one locality, but are brought into contact with each other and with many adults. *Consequently, the average minor, through his wide range of activity in employment and closer contact with other employees, exposes himself more to infection from tuberculosis or some other communicable disease than a given adult in the same department. It is obvious, therefore, that in order to determine with any considerable degree of accuracy the prevalence of tuberculosis among employees in factories, State Inspectors of Health should be given the same authority to obtain information concerning the health of adults as the health of minors.* It is probable that a comparatively small proportion of cases of tuberculosis exists among minors, who, because of lack of information concerning the prevalence of this disease among adults, are unprotected from the real source of infection and possible disease. Following is a case to the point: an adult employed in a cotton mill was found putting cotton in hoppers in a machine preparatory to the process of carding. He was in an advanced stage of pulmonary tuberculosis and expectorated freely and promiscuously. It may be stated that the cotton handled by this man was later handled by many other employees. In the case in question the man was removed from the mill and the local board of health was notified, so that proper precautions might be taken to prevent the spread of the disease, both within and without the factory. Doubtless, many similar conditions exist in our mills, as it is a fact that adult employees if in ill health will often conceal their state of health until actual disability causes them to give up their employment.

Prevalence of Tuberculosis among Children employed in Factories in Berkshire County.

By Lyman A. Jones, M.D., State Inspector of Health.

In order that we may judge intelligently as to whether we are securing results in our work which are worth the effort and expense, it is important to pause now and then to consider the relative value of the work; in other words, to determine the percentage of results in comparison with the proportion of effort or expense which the work calls for. It is in this connection that I am outlining a study made with reference to the prevalence of tuberculosis in my locality.

As the result of making as careful an examination as circumstances permitted of some 3,000 persons under twenty-one years of age, I discovered only 2 or 3 who were actually ill with pulmonary tuberculosis. While it is probable that if certain of the minors had been examined under suitable conditions other cases of this disease would have been discovered, I have reason to believe that were such examinations made the number of cases found would be surprisingly small. To test, in a measure at least, the accuracy of such a belief, a study was made of all the deaths from pulmonary tuberculosis in North Adams and Adams, with special reference to age and occupation, so far as data were obtainable, for a period of ten years. In these two places the cotton industry, in which foreigners are largely employed, is well represented. During the ten years from 1900 to 1909, inclusive, there were recorded for the two communities mentioned 495 deaths from pulmonary tuberculosis. In 108 cases the deceased was under twenty-one years of age, while in 387 cases the age of the deceased was over twenty-one. One difficulty encountered at the outset was the lack of information in the returns as to the nature of occupation. In 129 cases the occupation was given with sufficient definiteness to show that the deceased was employed as an inside mill worker. Of this number, 22 were under and 107 were over twenty-one years of age. Of the 129 inside workers, 85 were said to be cotton mill employees, 15 of whom were under twenty-one years of age. In the cotton industry, therefore, on the basis referred to, there were on an average but 17.6 per cent. deaths per year of minors from pulmonary tuberculosis, for North Adams and Adams. This discovery will in a measure tend to bear out the observation that there are but few minors with pulmonary tuberculosis employed in cotton mills in Berkshire County. It is probable that the small percentage given is more favorable than would be shown to be the case in some of the eastern industrial districts. Berkshire is high, the air is excellent, and its cities and towns, with the exception of a few limited areas, are not unduly crowded. Moreover, there are less uneducated foreigners here than in the more densely settled industrial sections. While these conditions undoubtedly exert a favorable influence, the results nevertheless point to the conclusion that the greater number of cases of tuberculosis are among adults; hence it follows that the greater problem in dealing with the prevalence of tuberculosis in factories is to control the disease among the adults, and thus to prevent the spread of infection to healthy adults and to minors. The question, therefore, becomes one of proportionate effort and returns. The law should make it possible to inquire into the health of the adult employees, and until this step is taken the full gain and benefit of the examination of minors, so far as it relates to the prevention of the spread of tuberculosis at least, cannot be secured.

In interviewing and examining minors it is a matter of frequent occurrence to meet children in the cotton mills who are small and undersized. These children generally show no evidence of disease at the time of the examination, although one naturally questions as to whether some of them are likely to develop tuberculosis at a later period. An attempt, therefore, was made to gain some information which might show whether this lack of growth or development was due to the conditions under which the minors were employed, or whether it was due to outside conditions. To this end a special study was made in three cotton mills, where 889 minors were employed. Of this number, 326 (148 males and 178 females) were under sixteen years of age, 100 of whom (60 males and 40 females) were undersized and under weight. The largest proportion of these minors were employed in the spinning, weaving and carding rooms. The fact that the children had been at work for a length of time not exceeding two years, and that 67 of the 100 who were observed to be undersized and under weight had been employed less than one year, made it appear to be reasonably conclusive that the abnormal weight and size were not due to the conditions of employment. Moreover, the mills in question were modern in construction and well appointed from a sanitary point of view. That outside conditions, including home management, were much more responsible for the lack of growth seemed evident. Such conditions as crowded rooms, improper food and irregular habits appeared to offer relatively much greater opportunity for fostering disease than the time spent in the well-appointed modern factories. In this connection the question of nationality was also interesting, for more than half of the 100 minors were of foreign parentage, a large proportion of whom were of smaller stature than the Anglo-Saxon people.

Thus the influence of home and outside conditions upon the health of persons who are employed in factories emphasizes the fact that health inspection work, whether in the factory or in the home, in order to promote effectively public health, must be done under the guidance of the central health authority of the State. The problem of preserving the health of factory employees cannot be successfully solved without striving to improve all the factors or conditions in the community which may affect it.

TYPHOID FEVER.

Eighteen cases of typhoid fever were investigated in Amesbury. Fifteen of these cases appeared in houses with bad sanitary conditions. The attention of the local board of health was called to the matter. In one instance, a woman who was nursing her child, ill with typhoid, was at the same time acting as clerk in a small store where milk was sold by measure to small consumers. The attention of the local board of health was called to the matter, but no action was taken by them.

Over 100 cases of typhoid fever in Brockton were investigated. Investigation failed to disclose the water supply or milk as being responsible for the cause of the spread of the disease. Many cases were found in that portion of the city where Polanders live. Eighteen of the 34 cases which occurred in August were in this section, and 6 of the 34 cases came from outside of the city. It appeared that in all probability many of the cases were the result of contact.

Investigations were made of cases of typhoid fever in Fall River and New Bedford. It was observed that by far the largest number of cases of this disease occurred among people while on, or who had recently returned from, vacation. Many of the cases were of a mild type, so that some doubt arose as to the correctness of the diagnosis.

Several cases of typhoid fever were investigated on dairy farms in Hardwick. Milk from these farms was stopped until danger from infection had passed.

A number of cases of typhoid fever occurring in Lynn and Swampscott were investigated. A milk supply suspected as being the source of infection was shut off and the outbreak subsided.

Small outbreaks of typhoid fever were investigated in Marblehead and Lowell. One tenement house in Lowell occupied by a number of Polish families was found with the water shut off, because the landlord had neglected to pay the water bill. The water-closets were in a filthy condition, and the tenants were taking water for drinking purposes from the polluted water of the Merrimac River. Three cases of typhoid and 1 death occurred in this tenement house.

Nine cases of typhoid fever occurring in Rowley during the month of August and the first two weeks of September were investigated. Two of these cases were probably imported and in two the diagnosis was doubtful. One family in which a person was sick with typhoid was found to be shipping milk to a Boston dealer. The attention of the local board of health was called to the matter and the shipment of the milk was discontinued.

Several cases of typhoid fever occurring in Sterling Junction were investigated. It appeared that one of the patients had delivered milk in houses where the other cases occurred and that in all probability this patient was a source of infection of the other cases.

At the request of the Swampscott board of health an investigation was made of an outbreak of typhoid fever in that town. The supply of one milk dealer was shut off on account of objectionable conditions that were found on his premises. The outbreak immediately subsided. The source of the infection could not be determined.

Five cases of typhoid fever occurring among the nurses of a hospital in Health District 14 within a period of eighteen months were investigated. In each case the disease appeared to be the result of contact infection. Recommendations were made through the local board of health for measures to be taken to minimize the infection through this source.

Report on an Outbreak of Typhoid Fever in Wayland during July and August, 1910.

After many months of absolute freedom from typhoid it became apparent at the end of July that an unusually large number of cases of the disease existed in the town of Wayland. An investigation showed that on June 12 a shoe worker from Lynn, ill with typhoid, came to his home in Cochituate. He was nursed at his home until June 21, when he was removed to the Natick Hospital. No other cases of the disease occurred until July 4, on which day 1 case was reported. The number of cases then rapidly increased, the outbreak reaching its maximum on July 25, when 8 persons were taken ill with the disease. New cases kept occurring daily to August 5, on which day there were 6 new cases. Between August 5 and August 22, 12 other cases occurred, 7 of these latter cases being in families where the disease already existed; these were in all probability contact cases. In all, 83 persons came down with the disease in this outbreak.

The cases occurred as follows: —

June 12, . . .	1
July 4, . . .	1
July 10, . . .	1
July 14, . . .	2
July 15, . . .	2
July 16, . . .	1
July 17, . . .	1
July 18, . . .	2
July 19, . . .	1
July 20, . . .	6
July 21, . . .	2
July 23, . . .	2
July 24, . . .	4
July 25, . . .	8
July 26, . . .	1
July 27, . . .	4
July 28, . . .	1
July 29, . . .	4
July 30, . . .	2
July 31, . . .	2
Aug. 1, . . .	2
Aug. 2, . . .	2
Aug. 3, . . .	2
Aug. 4, . . .	2
Aug. 5, . . .	6
Aug. 6, . . .	2
Aug. 10, . . .	4
Aug. 13, . . .	2
Aug. 15, . . .	1
Aug. 20, . . .	1
Aug. 22, . . .	2

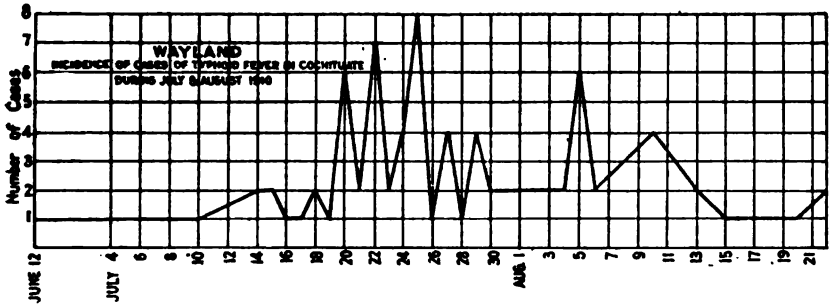
The age periods of those taken ill is shown in the following table: —

1 to 5 years, ...	5
6 to 10 years, ...	9
11 to 15 years, ...	6
16 to 20 years, ...	8
21 to 25 years, ...	9
26 to 30 years, ...	13

31 to 35 years,	6	56 to 60 years,	2
36 to 40 years,	7	61 to 65 years,	1
41 to 45 years,	4	66 to 70 years,	1
46 to 50 years,	5	Over 70 years,	1
51 to 55 years,	4		

From an examination of the chart, showing the incidence of the cases, it can be seen that it was a slow, continuous infection, reaching its maximum in the last week of July, and, excluding the contact cases, the number diminishing to the end of August. Five cases occurring in Waltham, 1 in Newton and 1 in Peabody are, for reasons stated below, included in this outbreak.

An investigation of the outbreak at the end of July pointed to one milk supply as the source of the infection, since all the cases occurred on the route of one dealer, whom we will designate as E. All the subsequent cases were on the same dealer's route. Further evidence that this milk was the source of the infection was obtained from the fact that 5 cases in Waltham, 1 in Newton and 1 in Peabody were traced to this milk supply. Two cases in Brockton and 1 in Milford were also traced to the same source.



E did not produce any milk, but got his supply from five different farms. An inspection of all the farms did not reveal any source of infection. One member of the family on one of the farms had typhoid fever ten years ago. An examination of the blood, however, gave a negative Widal test, and an examination of the urine and stools did not reveal the presence of typhoid bacilli. Mr. E's facilities for carrying on his milk business appeared to be adequate. Good facilities were provided for washing and cleaning the milk cans, bottles and utensils. The water supply on his premises was from the public water system. No history of any illness on his premises could be obtained. On August 8 E was stopped from delivering milk in the town, but B, the producer from whom E obtained most of his supply, was permitted to distribute to E's customers. Later B was informed by the local board of health that he must not bring any of his milk to Cochituate, but, curiously enough, he was informed that he could sell his milk in any other place.

As the town had no sewerage system, and each house had its individual privy, the local board of health was advised to urge complete disinfection of the excreta in each case, and to prohibit the removal of milk bottles or other containers from houses where persons were ill with the disease. These precautions were carried out.

While the milk supplied by E was undoubtedly responsible for this outbreak, yet from the fact that the outbreak was not explosive in its character and from the absence of any source of infection on the premises of E or on the farms where he obtained his milk, the disease in all probability was spread by contaminated milk bottles taken from the houses where persons were ill with the disease.

The first case that came from Lynn in June was supplied with milk by E until June 21, when he was removed to the hospital. The milk bottles were taken from the house where this person was ill to the milk house of E, where they were cleaned. This practice of removing milk bottles from houses where persons were ill with typhoid continued to the early part of August, when it was prohibited by the local board of health. There was thus an opportunity of spreading the disease by contaminated bottles.

Report on an Outbreak of Typhoid Fever in One Mill in Fitchburg between July 15 and Sept. 6, 1910.

From July 15 to Sept. 6, 1910, 86 cases of typhoid fever were reported to the Fitchburg board of health. Seventy-eight of these cases were employees in one large cotton mill; the other 8 were sporadic cases and had no connection with this mill or with the people working there. These 8 sporadic cases are not an unusually large number for the summer months in a city as large as Fitchburg.

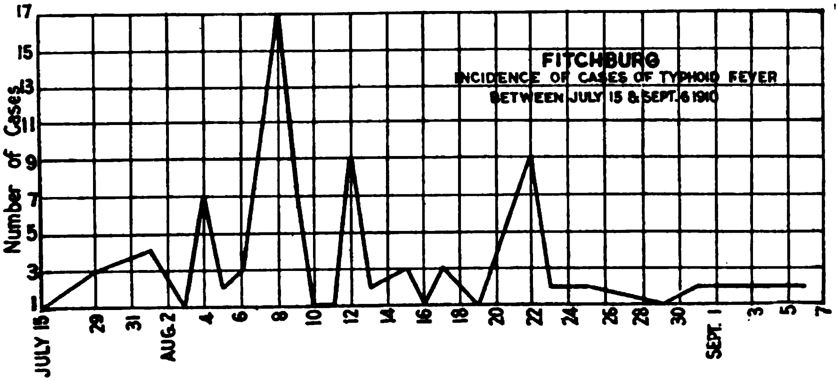
The 78 cases occurring at the mill evidently had a common source of infection. The incidence of the cases is shown in the accompanying chart.

The first case of typhoid connected with the mill was reported to the local board of health on July 15. Two weeks later another case was reported, and from that time till August 8 the epidemic was on the increase, there being 17 cases reported on that date. After August 8 the number of cases reported gradually decreased, although on August 22 there were 9 cases. The last case of this outbreak was reported on September 6. All cases reported at the end of August and those in September were found to have had a probable onset of the disease in the early part of August, but were kept under observation till a positive diagnosis was made.

The employees at the mill who were taken sick did not all live in one locality, but were scattered all over the city. So far as it has been possible to ascertain, all of the houses in which they lived were connected with the sewer and were supplied with the city water.

That the milk or ice supply played no part in this outbreak was shown from the fact that of the 78 cases not more than 3 or 4 bought their milk or ice from the same dealer, and these dealers had customers all over the city. Employment at the same mill was the only common factor in all the 78 cases.

Conditions at the Mill. — The drinking water at the mill was taken from the city supply, and at the time of the outbreak of the epidemic was put into pails with wooden covers, which also contained ice. These pails were placed on shelves about 5 feet from the floor, directly under the taps containing the city water. There were also faucets connected with a water supply used for washing purposes only. This water was taken from a near-by brook, which is formed by the overflow of the Marshall reservoir. There were signs over each faucet designating which was the drinking water. The pails containing the city water were also equipped with faucets, so that the operatives would not have to dip into them with the tin dippers which were furnished. It was the custom, however, with a great many of the operatives to remove the cover at the top of the pails and dip in with the cups, as the water could be obtained more quickly in this way. It was also a common practice to rinse the drinking cup with the water from the faucets intended for washing purposes only. The ice, before being put in the wooden pails, was often also washed with the same water.



The ice was given out by a foreman to the various boys in each room who took care of these pails. The pails were filled at least twice a day, sometimes oftener, and were frequently washed. As far as could be ascertained, none of the persons handling ice, either connected with the ice company or at the mill, had been sick.

It was learned that occasionally the operatives were in the habit of drinking from the wash-water taps, as most of the help were foreigners and could not read the signs designating the drinking water.

The stream which furnished the wash-water supply, as already stated, is in part fed by the overflow of the Marshall storage reservoir, situated perhaps one-third of a mile north of the factory. The brook runs through the mill yard, and part of it is diverted into a large barrel sunk into the ground, with a house over it, the water being pumped from this barrel into the pipes in the factory. This brook receives serious pollution at two points: one, only 150 feet away, where there is a Greek grocery store. The privy of this store is situated directly over the stream. At least two people used this all the time, and the Greek had frequent visitors of whom nothing was known; and although he claimed that there had been no sickness in his house, it is impossible to verify or disprove this statement. The upper floor of this house was said to be connected with the sewer, but as yet the privy downstairs was still in use. The other source of pollution is a large dump situated on the very banks of the brook, at a point 200 or 300 feet above the point just mentioned Here there were all kinds of rubbish, old bedding and garbage, and the brook probably received very serious pollution from this dump at times of rain.

Samples for chemical and bacterial analysis were taken from Marshall Brook at the point where it was collected for use in the factory. The water did not look very turbid, although there was a good deal of matter in suspension and a noticeable disagreeable odor. A chemical and bacteriological analysis showed slight pollution. No colon bacilli were found.

In addition to the above-mentioned water supplies there is in the mill yard, at a point about 20 feet from the engine room, a spring which has been there for fifteen or twenty years, and the people in the vicinity have been in the habit of drinking water from it, without serious results. It has never been known to dry up in the summer time.

The temperature of the water in the spring was 52° F., while that of Marshall Brook, the nearest body of water, was 62°. This indicated that the spring water was probably derived from the ground, and not from some surface source. A sample of this water was taken for chemical and bacterial analysis, and showed slight, if any, pollution.

Of the mechanics, foremen or engineer, who drank the spring water almost exclusively while at the mill, none has come down with the disease. None of the women at the mill, although they formed the great majority of those taken sick, was ever seen to drink from this spring. These facts seem to eliminate the spring water as a cause of the epidemic.

It would seem from the above facts that the infection took place by means of the water supply in the mill. There were two possible sources for such an infection.

(1) An operative having contracted the disease outside of the factory infected the ice-water pails with the drinking cup.

(2) The wash-water supply was exposed to pollution by human excreta not far from the factory. Some of the operatives drank this water, others rinsed the drinking cups with it and the ice put in the pails was often washed with this water.

The objection to the first possibility is that the cases were not limited to operatives working in any one part of the building, but occurred among the operatives in various departments. The water pails in the various departments had to be infected to give rise to this widespread infection in the mill. Moreover, the incidence of the cases, even if we assume that the cases occurring in the latter part of August and early in September were infected in the early part of August, would indicate that the infection lasted for a period of two weeks or more. This would not be likely if the pails were infected by a person ill with the disease.

The wash-water supply, on the other hand, was open to two sources of pollution, was common in all parts of the mill, and was used continually, and might well have given rise to all the cases.

During the first week in August the water pails were removed and the wash-water supply was shut off. No cases were reported after September 6.

Report on an Outbreak of Typhoid Fever occurring in Ipswich during August and September, 1910.

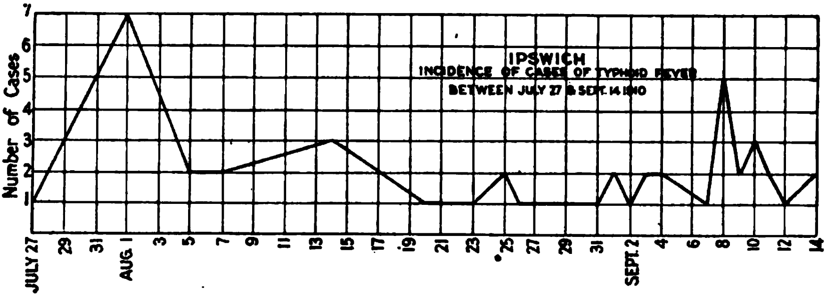
After several months of absolute freedom from the disease, a case of typhoid fever was reported to the board of health of Ipswich on July 27. From that date on new cases occurred almost daily to September 14, when the last 2 cases of this outbreak occurred. The total number of cases reported to the board of health between July 27 and September 14 was 42.

The cases occurred as follows: —

July 27, ...	1	Aug. 7, ...	2	Aug. 23, . . .	1
Aug. 1, ...	7	Aug. 14, ...	3	Aug. 25, ...	2
Aug. 5, ...	2	Aug. 20, ...	1	Aug. 26, ...	1

Aug. 31, . . .	1	Sept. 4, . . .	2	Sept. 10, . . .	3
Sept. 1, . . .	2	Sept. 7, . . .	1	Sept. 12, . . .	1
Sept. 2, . . .	1	Sept. 8, . . .	5	Sept. 14, . . .	2
Sept. 3, . . .	2	Sept. 9, . . .	2		

Distribution of the Cases. — With the exception of 4 cases all the cases of the disease occurred in a district inhabited by Polanders and Greeks. Of the 4 cases outside of this district 2 occurred on the milk farm of D. A boy of seven years on this milk farm was taken ill with typhoid on August 23, and on September 9 Mr. D. himself was reported ill with the disease, in all probability contracting the disease by contact with his boy. Seventeen cans of milk were produced daily on this farm and sold to Mr. J., who disposed of all his milk in Ipswich, but only 2 cases occurred on J's route. The local board of health issued rigid instructions to guard this milk supply. The source of infection of the disease on this farm could not be determined. It was learned, however, that some Polanders from the infected district had been at work on this farm previous to the illness of the boy, and it is possible that they brought the infection with them.



The other 2 cases occurring outside of the infected district could not in any way be connected with the general outbreak in that district, and no apparent source of infection could be traced.

General Characteristics of the Outbreak. — This outbreak is characterized by its rather explosive character, 7 persons being taken ill on August 1, and its very slow decline, new cases appearing at frequent intervals for over six weeks. It was limited to one section of the town, and almost exclusively limited to one class of the population, — the Poles and Greeks.

Milk Supply. — Of the first 15 cases of the disease that occurred 11 obtained their milk from Mr. P., who produced 7 cans of milk daily on his small farm, and distributed it among the Poles and Greeks in the district where the disease occurred. A visit to the P. farm revealed the following conditions: during the summer, the cows, 7 in number, were kept in the pasture all the time. Mr. P. went to the pasture to milk the cows and brought the milk to the farmhouse. The barn in which the cows were kept in cold weather was dirty, and the facilities for washing cans, pails and bottles were extremely bad. A galvanized iron washtub and wash boiler provided for the purpose were in a dirty condition, and had recently been used to mix grain for the cows. The water for washing the milking utensils was taken from a well located within 10 feet of the house and evidently subject to surface pollution. The entire farm buildings and surroundings presented an unclean appearance. No history of recent illness on this farm was obtained.

Of the 30 cases which occurred subsequent to August 14, 20 were on the milk route of Mr. H., who does not produce any milk but buys from near-by farmers. His milk shed was clean in appearance, well maintained, with ample facilities for washing the utensils and bottling the milk. Mr. H. has about 400 customers on his route, and only about one-fourth of his supply went into the infected district. On August 10 Mr. H. bought the milk of P., but on account of the poor quality and uncleanly conditions he discontinued the use of the milk after two days.

From the fact that no cases of typhoid appeared among the customers of H. outside of the infected district, this milk can safely be ruled out as a source of infection.

Sources of Infection Other than Milk. — The houses inhabited by the Poles and Greeks were invariably found overcrowded, and social intercourse between them was very extensive. In one instance 19 visitors were found in one room where a person was lying ill with the disease. All were drinking beer in the room, and there was a free interchange of glasses. From such lack of isolation of patients ill with the disease the chances for contact infection were great, and it was highly probable that many persons contracted the disease by close association with those who were ill.

Moreover, as there is no sewerage system in the town each house has its individual privy. Typhoid discharges were thrown into these privies without previous disinfection. Thus scattered throughout the district were many foci of exposed infectious material, and, combined with the lack of screens over the windows and doors of the houses, the possibility of fly infection was very great.

On September 18 the board of health of Ipswich secured a house and converted it into a hospital. All the cases of typhoid which had not previously been removed to the Salem or Beverly hospitals were removed to this place. All the tenements where the disease occurred were visited and 2 unreported cases were discovered; these were removed to the hospital. Large amounts of chloride of lime were used freely in the disinfection of the privies in which it was known that typhoid stools had been deposited.

Conclusions. — From the somewhat explosive nature of the outbreak in its beginning, and from the fact that the great majority of the early cases used milk furnished by P., it would seem as if that milk was in all probability responsible for the early cases. The subsequent cases, however, spread over a long period of time, indicating a slow, continuous infection, and limited to one neighborhood, were in all probability the result of direct contact, or were infected from the privies by means of flies.

Typhoid Fever in North Adams due to a Chronic Carrier.

During the year 1902 there was considerable typhoid fever in North Adams, some 65 cases having been reported. There was also a good deal of talk among the physicians about a certain milkman, a Mr. C., who sold milk in many families where the disease occurred, and in one instance, at least, Mr. C. threatened to sue a physician who had advised the family of a customer to make a change in their milk supply.

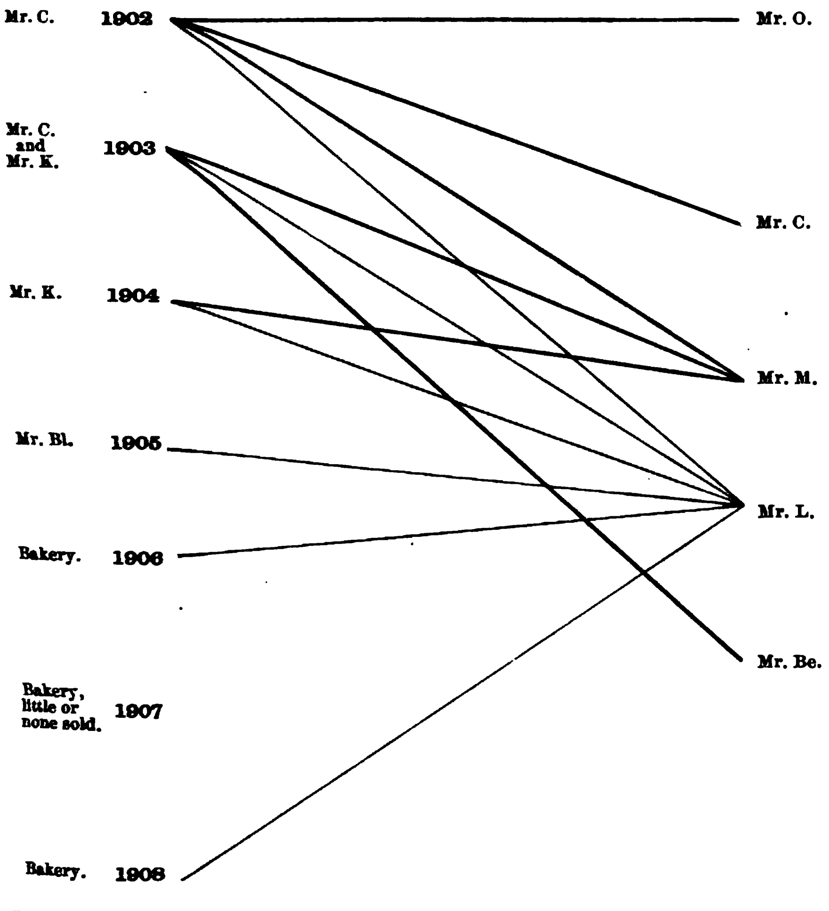
At the municipal election in December of that year new city officials were elected. This resulted in the appointment of a new board of health, which assumed its duties Feb. 1, 1903. Immediately the board appointed a physician, and assigned, as his first task, the investigation of the excessive amount of typhoid fever which the city had been having.

The 65 cases reported in 1902 were looked up in detail, each household was visited, and as full a sanitary history as possible of each case was obtained. Thirty-five further unreported cases were found. A tabulation of these cases showed that 21 out of the 100 were located largely in that part of North Adams called Houghtonville, adjoining Clarksburg, and that all of the 21 obtained milk from Mr. C. This led at once to an investigation of Mr. C's milk supply. Mr. C. sold about 75 quarts of milk daily to some 40 or 45 families. He obtained his milk from several sources.

From Mr. O. he secured 30 quarts daily. Mr. O. sold also 100 quarts daily to another retailer, who had no typhoid on his route, hence this supply could be left out of further consideration.

Mr. C. kept one cow, and obtained his water supply from a well midway between the house and barn, both of which were near, and the water was said sometimes to be foul. The sale of milk from this source was forbidden in North Adams by the board of health.

Mr. C. obtained a further supply of milk from the M. and L. dairies. These dairies were visited, and, while minor improvements were sug-



To illustrate how the L. Dairy was the one common source of infection during the years in question. Lines in red represent the distribution of the L. supply.

gested and some changes in the water supply required, nothing could be found to explain the infection.

Early in 1903 Mr. C. sold his milk route to a Mr. K., who took over Mr. C.'s supply from Mr. M. and Mr. L., and also bought milk from Mr. Be. Before selling out Mr. C. had 3 cases of typhoid, and during the remainder of the year Mr. K. had 12 cases, making a total of 15 cases for the year where milk from the M. and L. dairies was used. During the year there were 73 cases of typhoid fever in the city.

In 1904, Mr. K., who continued in the milk business, with the same sources of supply, had 4 cases of typhoid fever out of a total of 32. Before the first half of the year was up, on the strength of the above showing, the sale of milk from the M. and L. dairies was forbidden in North Adams by its board of health. In consequence of this restriction the M. dairy ceased the production of milk, and shortly after Mr. K. went out of business.

During 1905, out of 37 cases of typhoid fever 9 were on the route of Mr. Bl. It was found that Mr. Bl. was obtaining milk from Mr. L. With other sources eliminated, the L. dairy seemed to be the one under suspicion. The sale of milk from this source was again forbidden in North Adams.

In 1906 the L. milk was sold to a baker outside of North Adams. In this year there were 32 cases of typhoid, 6 of which purchased milk at the bakery, where L.'s milk was exclusively used.

In 1907, out of 25 cases of typhoid fever, none could be attributed to this source. This was due to the fact that little or no milk was sold from the bakery, one or two families in the neighborhood who kept cows supplying the demand.

In May, 1909, between the 12th and 26th there occurred 7 cases of typhoid fever in North Adams. An investigation of these cases as they were reported led to the discovery that all but 1 used the products of a certain bakery, the same bakery where L.'s milk was exclusively used. Investigation at the bakery disclosed that 2 of the employees had been or were then ill with typhoid fever, that they worked for several weeks before they went to bed, and that they obtained their milk supply from the bakery where they were employed.

Notwithstanding frequent inspections and questionings at L.'s dairy in the past, no source of infection could be discovered. Further visits at this time brought out the fact that Mr. L.'s daughter, a middle-aged woman, had had typhoid fever in New York State over fifteen years ago. A sister had gone from her home here to care for this daughter, contracted the disease and died, while this daughter recovered, and soon returned to her father's home in Clarksburg, bringing her two children with her. Here she has lived since. During these fifteen years she has had five children. All seven children are well, and none of them have ever had any serious illness. The mother has had no other illness beyond what was associated with child bearing.

This information led to the taking of an immediate Widal test, which was positive. Following this, specimens of the urine and feces were examined at three different times. The first examination resulted in the finding of bacilli which closely resembled the paratyphoid bacillus. The second and third examinations were negative.

Since May, 1908, to the present time (October, 1909), there have been no cases of typhoid fever which could be traced to this source. This present season the production of milk for other than their own family use has been discontinued.

The absence of cases of typhoid fever from this source previous to 1902 is explained in that till then no milk was produced on the farm except for their own family use. At that time additional cows were purchased, and the milk was sold to Mr. C., as previously mentioned.

That the cases due to this infection were irregular in their appearance and number seems easily explainable, in considering the probable mode of infection of the milk. As a rule, Mr. L.'s daughter has had nothing to do with the milk. But the milk was taken into the kitchen for straining, and the cans were washed there. Nothing could be more natural than that, under special circumstances, the daughter volunteered to assist her father in the handling of the milk or utensils.

During the fly season further opportunity for infection also occurred, in that the privy was not far from the house, and was not screened from the flies, while the cans were left to dry near the house, where the flies found ready access to them.

In these two ways is the appearance of the disease traced to this source, irregularly, and at intervals to be accounted for.

It is also worth noting that while the L. dairy never produced over one one-hundredth part of the milk consumed daily in North Adams, one-fifth of all the typhoid in the community occurred in cases where this milk was used, if a few secondary cases be included. This proportion would be increased somewhat were the imported cases deducted.

SCARLET FEVER.

Several cases of scarlet fever, occurring on dairy farms in Boylston and Rutland, were investigated. Milk from these farms was stopped until the danger from infection had passed.

Small outbreaks of scarlet fever were investigated in Charlemont, Hatfield and Greenfield. In the two former places the disease was confined to two schoolhouses. The schoolhouses were disinfected. In the latter place the cases were on the route of one milk dealer. This supply was shut off and the outbreak terminated.

An outbreak of scarlet fever occurring in Holyoke was investigated. No common source of infection was found. The disease in all probability spread by contact, since many of the cases were mild, and many undoubtedly remained unrecognized. One child, for instance, with both hands desquamating, was found playing with other children.

The occurrence of 5 cases of scarlet fever in one family in Monson was investigated. It was found that the members of the family came down with the disease a few days apart. The physician attending these cases did not report them until after their recovery. The local board of health was advised to take action against the physician. Their action consisted in warning the physician to use greater care in the future.

At the request of the Palmer board of health 2 cases of scarlet fever were seen. One case was not reported by the attending physician, and the other case was reported as measles. The board of health was advised to take action against the physician. The case, however, was not taken into court, but the physician was warned by the local board of health to use greater care in the future.

An outbreak of scarlet fever was investigated in Plainville, and it was found that 6 of the 7 cases resulted from an unrecognized case which returned to school at the end of three weeks after the onset of the illness. The children of two schools closely adjoining were exposed to the disease. The following suggestions were given to the board of health by the State Inspector of Health: (*a*) thorough disinfection of the schoolhouses; (*b*) closing of schools for two weeks; (*c*) upon reopening the schools, the examination by the school physician of every pupil, especially for desquamation; (*d*) no child from a quarantined house to return to school after release from quarantine until examined by the school physician; (*e*) teachers to report to the school physician every morning for two weeks after the opening of the schools in case any pupil was ailing or if any were absent from school for an unexplained reason. The board of health adopted the suggestions of the State Inspector of Health, closed the schools and established quarantine. The outbreak soon ceased.

A small outbreak of scarlet fever in West Chelmsford and Westford was investigated. It was found that all the cases were attending the same school. Many other children showed general redness of the throat and slight fever, but no eruption; these in all probability were mild cases of the disease. Proper quarantine by the local board of health checked the outbreak.

Outbreak of Scarlet Fever in and about Boston during April and May, 1910.

During the last week in April and the first week in May an outbreak of scarlet fever occurred in Boston and suburbs.

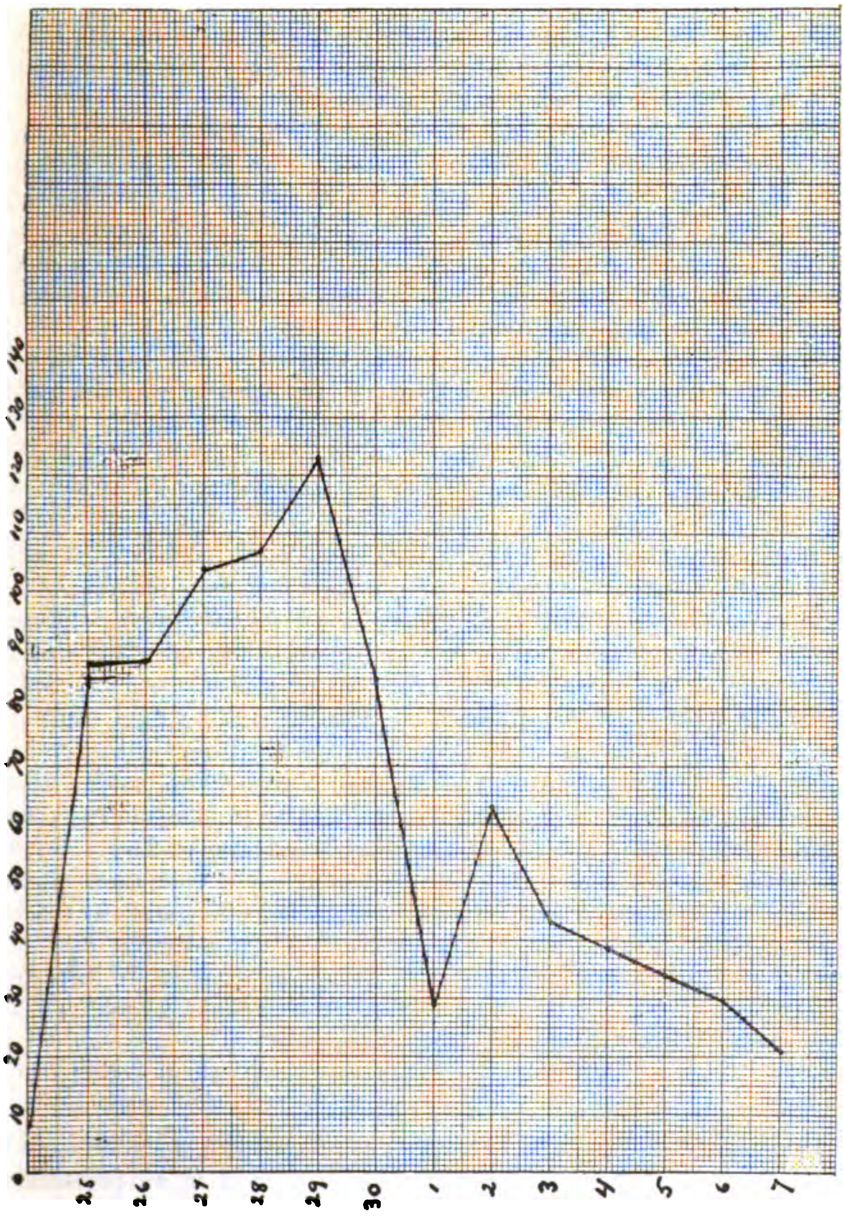
The following table shows the incidence of the cases as they were reported to the boards of health of the various cities between April 25 and May 7. The accompanying chart shows the total daily incidence of cases in all the cities where the outbreak occurred. The sudden drop of the cases on May 1 is due to the fact that it was Sunday, and, with the exception of Boston and Chelsea, no cases were reported to the boards of health.

LOCATION.	APRIL.						MAY.							Total.
	25	26	27	28	29	30	1	2	3	4	5	6	7	
Boston, ...	23	36	35	56	70	44	26	26	26	10	21	15	13	401
Chelsea, ...	3	2	1	2	10	5	-	6	4	2	3	3	4	45
Winthrop, . . .	1	1	8	1	2	1	3	-	-	1	-	-	-	18
Cambridge, . . .	18	11	27	10	21	14	-	9	5	7	5	3	3	133
Somerville, . . .	18	18	16	25	10	15	-	14	5	5	-	5	3	134
Malden, ...	14	13	15	5	6	3	-	3	3	4	1	3	1	71
Everett, ...	11	7	2	8	4	3	-	2	-	-	1	1	1	40
Totals, . . .	88	88	104	107	123	85	29	60	43	29	31	30	25	842

This sudden outbreak of scarlet fever so widely distributed, at a time of the year when no unusual number of cases generally occurs, pointed to a common source of infection. Investigation showed that most of the cases occurred on the route of a large milk contractor, who distributed milk in Boston and suburbs.

Of 409 cases in Boston, 286, or nearly 70 per cent., were on the route of this dealer, while 123, or 30 per cent., used other milk. Of the 155 cases that occurred in Cambridge (including 22 cases that occurred between May 7 and 14), 126, or over 80 per cent., were on the route of the same dealer. About the same proportion of the cases in the other cities used the milk of this dealer.

The earliest reports to the Boston board of health directed suspicion to this milk supply. Of the 23 cases reported on April 25, 16 were on the route of this large milk contractor, and immediate steps were taken by the Boston board of health to render the suspected supply safe by pasteurization.



Daily incidence of cases of scarlet fever in and about Boston from April 25 to May 7, 1910.

From the dates of the first symptoms of the early cases the first infection probably took place on April 20 or 21. An examination of the chart shows that the epidemic reached its highest mark on April 29, when 123 cases were reported, which would indicate that the outbreak was the result of more than a single infection.

There were certain circumstances connected with this outbreak which showed that the milk was infected as late as April 23. These circumstances were as follows: the week of April 24 was the Jewish Passover, during which festival only milk from a specially guarded supply, complying with certain requirements in the matter of handling utensils, cans, etc., is permitted. The contractor in question undertook to furnish milk complying with these requirements. It thus happened that a number of Jewish families, who previous to April 24 used other milk, began to use the milk of this special supply on April 24. On April 26 a Jewish child became sick with scarlet fever in a family who began to use the milk in question on April 24. Altogether there were 73 cases in Boston who used milk from this special supply. Of this number, 24 used other milk previous to April 24.

This special circumstance also pointed to the farms on which the milk was in all probability infected. The contractor gets the milk from some 250 dairies, all the milk being mixed at the central station. Eight dairies were set aside to furnish milk to the special supply. This special milk was handled separately and was not mixed with the general supply. Three of these 8 dairies entered in the general family supply previous to April 23. The milk from these 3 dairies was therefore common to the general family supply up to April 23, and to the special supply after that date; and since the infection occurred in both supplies, and as there appeared no possible source of infection at the central station, it would seem that the milk must have been infected on one of these three farms. A careful examination of these farms, however, failed to reveal any source of infection. On one farm it was learned that at the time of the outbreak one cow in the herd had some disease of the udder. Unfortunately, the cow was sent to be killed shortly before the inspection, so that the nature of the disease could not be determined.

DIPHTHERIA.

Six cases of diphtheria in Lenox were investigated; 5 of the cases were girls who attended one room in school. They were in all probability contact cases.

A case of diphtheria occurred in one of the large mills in Lowell, where many of the operatives were exposed to the infection. Advice was given to the management of the mill as to the necessary precautions to stop the spread of the disease. No other cases occurred.

Several cases of diphtheria occurring in one family in Rowe were investigated. It was found that the disease was brought from Boston.

Many of the small towns have appeared somewhat indifferent in the matter of forming and enforcing regulations relative to the prevention of the spread of this disease. This means that the protection of the public health has fallen mainly upon the judgment of the individual physicians. As a result of the lack of definite local regulation an outbreak developed in the town of Swansea. A person ill with diphtheria was allowed to cross the line between Rhode Island and Massachusetts to go to one of a number of summer cottages. Five cases soon developed among the summer cottagers, and but for the prompt action of several health authorities a serious outbreak of the disease might have occurred. In the town of Fairhaven, after 16 cases were reported, prompt action on the part of the health authorities again prevented an epidemic.

Owing to the indifference of the foreign population, and their lack of confidence in and unwillingness to employ physicians, many cases of this disease have been allowed to run their full course without recognition. A fatality was sometimes the first evidence of the existence of the disease.

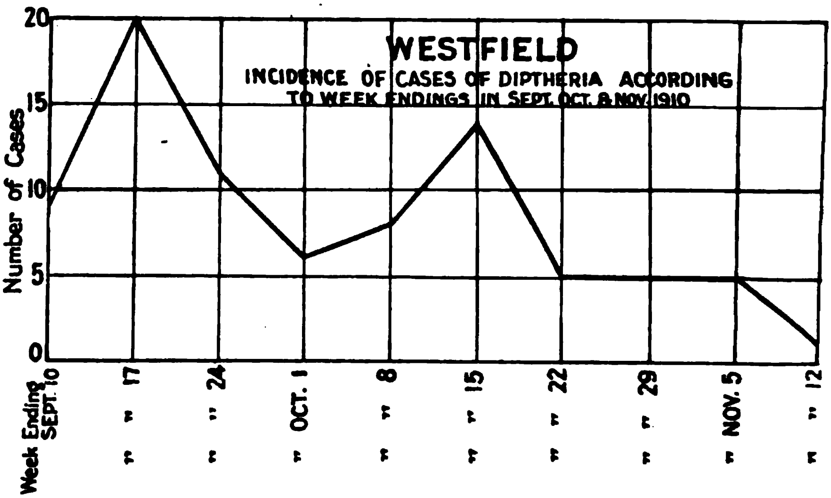
Small outbreaks of diphtheria were investigated in Townsend and Westford.

Report on an Outbreak of Diphtheria in Westfield during September and October, 1910.

The public schools in Westfield opened for the year's work on September 6. Many of the children were kept at home because of sore throats, consequently the school committee became alarmed and closed the schools from Monday noon, September 12, until Monday, September 19. Two cases of diphtheria were reported to the board of health, one on the 7th and one on the 9th. Both of these died on September 9. On the 14th the board of health made an inspection of all children reported by the school committee to be suffering from sore throats, and uncovered 7 cases that were clinically diphtheria. Five of these attended the Davis school on Bartlett street. The board of health ordered the school closed for two weeks, from September 15 to September 28. One of these cases had been sick since September 5. New cases were reported, so that by the night of the 17th, 22 were on file. During the next week 17 cases, and during the following week 3 cases, came down with the disease. On September 19 the board of health ordered all schools in the town closed until September 26. In the next week 11 new cases occurred, seemingly connected with the Davis school. This school was then closed for the last four days of the week, and some changes in the sanitary arrangements were made. The number of the cases then decreased, and early in November the epidemic ceased.

The accompanying chart shows the course of the epidemic according to the date of occurrence of first symptoms.

There was a total of 84 cases in this epidemic. Of these, 50 occurred in a quarter of the town occupied largely by Polish, Lithuanian, Slavic and Bohemian people. The cases were in the families of these people. The other 34 cases were spread over a large area, but in these latter cases, direct or indirect contact was shown to be probable, either through schools, churches, friendly visits or business.



In the country districts of the home lands of these people the only quarantine enforced ordinarily is one against smallpox, and that is of the strictest, police-guarded type. They do not believe that any other disease is contagious or preventable by that means. Therefore the enforcing of any degree of isolation of the patient or of quarantining the other members of the household is very difficult. Recognizing this difficulty, the board of health made no effort to enforce an efficient quarantine. They advised proper isolation, which was accomplished or not, as the case might be. Until their attention was called to the matter on October 10 by the State Inspector of Health of the district, diagnoses and releases were governed by clinical symptoms only. After that date a negative culture was required for release. The average period of quarantine in dwelling houses was 9.6 days, this not including 4 cases which died before a quarantine could be declared. Disinfection of premises after quarantine was removed was well attended to.

Thirty-one cases were taken to the hospital and treated in the isolation ward; 4 of these died almost immediately, 1 developed typhoid, and 1 scarlet fever. Excluding these 6 cases, the average period of detention was 6.6 days. These releases were all on clinical evidence; no cultures were taken.

No connection between this outbreak and any one milk supply could be established. Thirteen dealers supplied milk to the infected families, 3 of them to 10 or more each.

In the 54 infected families there were 134 adults and 188 children. In 41 of these no second case was reported. In 2 of the 13 families with more than 1 case there were 4 reported.

There were 8 fatal cases of the laryngeal type of the disease. The cases in general were mild, and as no cultures for diagnosis were required, it is probable that some of the cases were not true diphtheria. On the other hand, among the people chiefly affected a mild sickness in a child is not considered as anything requiring a doctor's attention, and a light case would pass unnoticed. Perhaps some cases were concealed. Many unrecognized cases in all probability occurred, and it is further probable that many cases were concealed for fear of quarantine.

The father of the third case reported was employed in a foundry. On the fourth day of its sickness the child was taken to the hospital for treatment. The board of health at no time during this epidemic interfered with the freedom of the wage earners of the infected families, and this man went to his work as usual. Within the next nine days 10 cases of diphtheria were reported from families the heads of which were working in this same foundry.

These families were divided as to nationality as follows: Bohemian, 2; Lithuanian, 3; Slavic, 3; and Irish, 2. These people spoke different languages and did not mix socially. The Bohemians went to the Lutheran church, the Slavs and Lithuanians to the Polish church and the Irish to two different Catholic churches. They did not have a common milk supply. While the Bohemian families, in whom the epidemic started, lived close together, the other families lived pretty widely separated; the two Irish families, for instance, lived about a mile apart, and were separated by a river. Six of these families had children attending three different schools. The school attendance did not seem to come into any prominence early in the outbreak, and later only as a gathering place for carriers of diphtheria germs. No apparent connection between these cases could be found, except that through the head of the family at his work in the foundry.

The school enrollment of Westfield is 2,481. The total number of school days lost during this outbreak, because of the closure of the schools and the exclusion of pupils either because of illness or quarantine,

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to the Lynn board of health in the diagnosis of 4 cases of smallpox. The board was advised as to the isolation of the cases and the vaccination of all persons who had come in contact with them.

Two cases of smallpox were discovered in New Bedford. One was a cotton mill operative; the source of the contagion remained unknown. The other case was imported on one of the trans-Atlantic liners. The usual quarantine was enforced in each case and a general vaccination ordered, in the one case among the operatives in the department of the mill in which the man was employed, and in the other in the vicinity where the man was located.

Several cases of smallpox occurring in North Brookfield were investigated, and the local board of health was advised as to the necessary precautions to stop the spread of the disease. A general vaccination was carried out in the town.

Smallpox in Wakefield, Reading, Stoneham and Melrose.

On Jan. 8, 1910, the board of health of Wakefield called to the attention of the State Inspector of Health of the north metropolitan district a case of smallpox in that town. Investigation of this case and the cases preceding and following it showed that a total of 54 cases occurred in Wakefield, 29 in Lynn, 5 in Stoneham, and 1 in Melrose. Twenty-five of the cases were among children under ten years of age. Of the total number of persons stricken 46 were females and 43 males.

The first case concerning which any history was obtained was that of a woman, M. B., twenty-three years of age, who was taken ill on Sept. 27, 1909, never having been vaccinated. Her sisters, B. and D., were taken ill on October 10 and 18, respectively. Of these 3 patients the first, M. B., was attended by a physician who diagnosed her illness as influenza. Later, when an eruption appeared, the patient was seen in consultation with another physician, and it was decided that she had chicken pox. A careful examination of these 3 patients later on (January 20), however, showed unmistakable evidence of the remains of smallpox eruptions on the face and forearms of each. The patients had all worked at the Harvard Knitting Mill, and, because of failure to recognize the presence of smallpox, formed a source of infection to other persons with whom they came in contact.

On November 13 a man, E. S., thirty years of age, employed at the same mill, was taken ill with the disease. He also had consulted a physician, who diagnosed his illness as influenza.

On December 1 another employee at the knitting mill, L. L., was taken ill with smallpox, although unattended by any physician, and on December 15, 5 other members of her family had symptoms consistent with the disease. An examination made on February 11 showed positively that all these persons had been stricken with the disease.

On December 9 another employee at the knitting mill, M. F., had symptoms of smallpox, and on December 24, January 10, 11 and 17, 4 other members of the same family were taken ill. An examination made on January 19 showed that they also had the disease.

On December 9 another employee, E. K., and on the 25th her brother, J. K., showed symptoms of the disease, both cases having been unrecognized.

On December 15 a woman, M. M., and on the 21st her sister, M. M., both employed at the knitting mill, contracted smallpox, and later 7 other persons in the same family showed symptoms of the disease, being stricken in the period between December 25 and January 6. In the same house 6 members of another family contracted the disease during the period between December 25 and January 23.

On December 21 another employee at the knitting mill, C. G., was taken ill with smallpox, and later, between December 26 and January 9, 4 other members of her family were stricken. In an adjoining house, where a relative lived, 3 members of the family were stricken between January 17 and February 5. The first group of cases was unrecognized, but the last 3 cases — occurring at a time when a definite diagnosis of smallpox had been made — were recognized.

On December 21 another employee at the knitting mill, R. C., was taken ill with the disease, and during the period between January 3 and 12, 4 other members of the family were stricken, the first being unrecognized.

A. C., stricken December 22; P. F., December 24; A. M., December 27 (the latter infecting her mother, who was taken ill on February 6); M. W. and V. S., January 2; A. F., January 12; and L. W., January 14 (whose father was ill on February 1), — all worked at the Harvard Knitting Mill.

With this widespread infection existing unrestricted from Sept. 27, 1909, until Jan. 8, 1910, it was expected that other persons would contract the disease, and at the house of L. B., where E. S. visited, 3 of the family were ill between December 10 and 25, and 4 members of the family in an adjoining house were ill between January 1 and 11. Two other persons, R. M., who visited the house of L. B., in December, and L. S., who visited the same house, were taken ill on December 24 and January 9, respectively. R. M. lived at Stoneham, and 2 members of his family were stricken with the disease on January 12 and 17. A man who lived in an adjoining house and another man who worked on the same premises were taken ill on January 12 and 30, respectively.

D. B. was taken ill with smallpox on January 1 and her mother and brother were stricken on January 12. K. C. was taken ill on December 25 and 7 other members of her family were ill with the disease between January 10 and February 2. V. B. and H. B. were stricken on December 25 and 26, respectively, and another member of the family had the disease on January 8.

Two persons in another family were stricken with smallpox on December 31 and January 17, respectively. Six other cases occurred in different families between January 1 and February 11, inclusive.

When it was apparent to the boards of health of the towns of Reading, Wakefield, Stoneham and Melrose that smallpox was so widespread the most stringent measures were taken to control the epidemic. At Reading a house in which most of the cases existed was used for a hospital, the well members of the family being removed and patients in other families being transferred therein. At Wakefield the board of health obtained the use of a house owned by the town, situated on the shores of Lake Quannapowitt, and fitted it for a hospital. The building was opened for smallpox patients on January 12. At Stoneham the patients were cared for in the houses where they lived. Only 1 case occurred in Melrose. The health authorities of the towns of Wakefield and Reading closed the schools and churches and prohibited all public entertainments. Vaccination was ordered in all of the manufacturing establishments in each town, and free vaccination stations were opened at the town halls, with the result that practically all the inhabitants were vaccinated in the course of a few days. With such extensive restrictions, notwithstanding the widespread character of the disease, the infection showed signs of immediate abatement, and the epidemic was well under control. The hospital at Wakefield was closed on March 5, and the last visit was made for patients at Reading on March 11.

During the entire epidemic only 9 of the 90 persons stricken were found to have been vaccinated. Of this number 8 were between the ages of twenty and eighty-four, and had not been vaccinated since childhood. One girl, eleven years of age, who was vaccinated six years previously and showed only a slight scar, had the disease in a mild form.

In addition to the 90 cases of smallpox, above mentioned, 48 visits were made to patients who were reported as being possibly infected with the disease. During the epidemic 32 daily visits were made to the towns wherein the disease spread, for the purpose of assisting the local health authorities in controlling infection.

MISCELLANEOUS INFECTIOUS DISEASES.

Many outbreaks of measles, whooping cough and chicken pox were investigated during the year by the State Inspectors of Health, and in every instance the local boards of health were advised as to what precautions to take to check the spread of the diseases.

One case of tetanus developed in Fall River, following vaccination by the school physician. The vaccine virus used was not supplied by the State Board of Health. The patient was treated with anti-tetanic serum and recovered. A case of tetanus occurred in Dartmouth; the patient received similar treatment and recovered.

A severe epidemic of dysentery, during the summer months, was investigated in Shirley village. There were about 40 cases in all and 10 deaths. The deaths occurred in children under one year of age. Bacteriological examinations were made of the stools and the Shiga bacillus was found. It was conclusively shown that the disease had spread by contact. The first cases appeared at a cross road, and a number of other cases soon followed in the immediate vicinity. A cousin visited one of the infected children, and a few days later she was taken sick at her own home, about half a mile away. A short time later several cases occurred in this locality.

The privies of the houses where the disease occurred were found to be in an unsanitary condition, and the local board of health was advised to enforce better sanitary conditions. Strict quarantine of all the cases was advised.

An alleged outbreak of several cases of cerebro-spinal meningitis in a candy factory in Boston was investigated. No foundation for the report was found. A visit to the home of one of the workers who had been out for over a week showed that the young woman had an attack of acute follicular tonsillitis, from which she was recovering.

Cases of anterior poliomyelitis were investigated by the State Inspectors of Health within their respective districts and detailed information concerning them was submitted to the office of the State Board of Health. This part of the work is included in the special report on anterior poliomyelitis.

All diseases dangerous to public health reported from tenement workrooms were investigated; the premises were visited and whenever necessary the licenses were revoked.

DEALINGS WITH LOCAL BOARDS OF HEALTH.

In order to appreciate the time and effort devoted to work with local boards of health, and to account for the frequent lack of results following such work, or at least the lack of results which can be definitely stated, it is well to mention some of the conditions under which such work is done.

In many places, in the absence of a distinct board of health, their duties are assumed by the selectmen, together with the numerous duties pertaining to the general business conduct of the town. The selectmen are usually laymen, unfamiliar with and having no special knowledge of health matters. Hence, they are often uninterested or unappreciative of the importance of health conditions. In some instances this is due simply to lack of knowledge.

Further, being subject to annual election to office, or re-election, health matters are sometimes prone to be considered from the standpoint of possible political effect rather than from the standpoint of health. One set of officials who have become interested gives way to another set of officials who are unfamiliar with health work, and the work must be done over again.

Throughout the State the selectmen act as boards of health in 154 towns.

In the cities and towns where there are distinct boards of health, political changes also occur, the tenure of office is uncertain, and the salary, if any, is frequently not sufficient to secure those most competent to fill the position.

Throughout the State there are 158 towns or cities where there is no physician associated with the board of health, either as member, adviser or agent.

In many places there is a tendency to pass over health work as of little importance, since no appropriation is made for the health department. Bills, if any, are paid from general or contingent funds.

Under these conditions there is ample ground for maintaining that the best health work will not be accomplished until there is devised some means of securing and retaining interested and efficient local health officers, who shall be properly paid and who shall have necessary means with which to carry on the work.

Many boards of health, however, are taking an increasing interest in their work and are requesting the assistance of the State Inspectors of Health with growing frequency. The subjects upon which information or assistance is desired cover the whole range of health work.

Numerous special conferences have been held with boards of health in securing information as to health practices throughout the State.

Aside from the conferences above mentioned, the interest of the local health authorities has been aroused through the making of special inspections or investigations jointly with members of the board or their representatives. In this way it has sometimes been possible to secure action which might not have been taken otherwise.

In other instances letters are often sent to local boards stating facts or information that has come to the knowledge of the inspector, asking them to make inquiry as to the matter in hand, and to notify the State Inspector of Health concerning whatever action is taken.

It frequently happens that an inspection of the death returns in a given locality will disclose cases of communicable disease which have not been reported. In such instances a communication may be made to the local board, asking them to investigate. A communication may be sent also directly to the physician concerned. If this is regularly done, it will prove of assistance in securing more accurate reports of cases.

In many instances it has been possible to aid local boards of health in the settling of various matters, some of them concerning petty questions of long standing, by pointing out the statute provisions bearing upon the question in hand.

In some instances assistance has been rendered in the planning of records which show the results of work done, and at the same time afford data for comparison and future study.

NUISANCES AND CAUSES OF SICKNESS.

In the abatement of nuisances and causes of sickness the State Inspectors of Health have only advisory authority. They investigate all influences that are or may be dangerous to the public health, and make such suggestions to the local boards of health as they deem necessary to promote the public health.

By nuisances is meant public nuisances, that is, objectionable conditions which affect the public or the community. In determining the existence of a nuisance, health, comfort, convenience and interest of the community are factors for consideration. Certain objectionable conditions may directly or indirectly affect health; they may tend to cause an individual to be more susceptible when brought in contact with infection, as, for example, foul and noxious odors, conditions of crowded tenements; or they may increase the means of infection, as, for example, accumulations of manure, by affording opportunity for the breeding and increase of flies, the pollution of drinking water by infection from badly located water-closets and cesspools. On the other hand, in order to amount to a nuisance it is not necessary that conditions shall be dangerous to health, for example that the corruption of the atmosphere should be such as to be dangerous to health; it is sufficient that the effluvia are offensive to the senses and render habitations uncomfortable. The more ordinary types of nuisances may be grouped as follows: —

1. Those created by emptying the sewage of dwelling houses through a private drain upon the surface of a private way on abutting private land.

2. Those which affect the purity of the sources of water supply, as, for example, the pollution of wells, springs, brooks and water courses, pollution of public water supplies by the disposal of manufacturing waste, the improper location of sewer outlets.

3. Those which make the occupation of neighboring houses and the passage over the adjacent highways disagreeable, as, for example, piggeries in which swine are kept in such numbers that their natural odors fill the air thereabout.

4. Those caused by privy vaults so situated as to be injurious to the public health.

5. Those caused by unfit dwellings which are liable to be a cause of sickness to the occupants or to the public.

6. Those caused by accumulations of manure, filth or refuse of any kind.

7. Those caused by land which is wet, rotten or spongy, or covered with stagnant water, so that it is offensive to residents in the vicinity or injurious to health.

8. Those caused by the exercise of any trade or employment which is hurtful to the inhabitants, injurious to their estates, attended by noisome and injurious odors, or dangerous to the public health.

9. Those caused by the emission of dark or dense gray smoke except under statute limitations.

During the year there were investigated in detail 109 nuisances in 15 cities and 55 towns. Of this number, 32 involved drainage conditions, stagnant water or the pollution of water supplies, 32 related to cesspools or privies, and 36 were caused by offensive trades, odors or offensive accumulations of manure and other refuse; the 9 remaining nuisances were of a miscellaneous type. In 60 instances efforts were promptly made to abate the nuisances; in 18 other instances the existing conditions were improved; in 31 instances the local board of health failed to carry out the suggestions made by the State Inspectors of Health. The reasons for such failure were (1) difference of opinion as to what constituted a nuisance; (2) prolonged consideration of the matter in question; and (3) inefficiency of the board.

Because of the frequent changes in the personnel of local boards of health, and the consequent inexperience of officials in dealing with such matters, or for political reasons, owing to the necessity of proceeding against persons of influence, especially in places where selectmen act as boards of health or where the membership of the board is elective, action is often delayed or neglected, even in cases where the complaint is well founded. Thus all health work is to a considerable extent adversely affected. There would seem to be no effective method of permanently improving the administration of local health work until a greater permanency of interested and efficient health officers is secured, or until there is some authority to force inactive health boards to do what is necessary to preserve the public health.

Complaints, of course, are not always well founded. They frequently allege conditions to exist on a neighbor's premises regarding which the complainant does not wish to appear personally, or they are the result of a desire for revenge for some imagined injury or some ulterior purpose. Complaints are commonly received by the State Board of Health because of the reluctance or delay of local boards to take action; when submitted by boards of health or organizations they are usually in the nature of a request for advice or a conference as to the best means of abating the same.

At times energetic action is needed. For example, a State Inspector of Health, during an investigation of the prevalence of typhoid fever in a given locality, discovered that the excrement of a considerable number of patients was thrown in privy vaults without disinfection. He stated that had recommendations been made relative to the structure of the vaults, the disinfection of their contents and screening against fly infection, and carried out early in the outbreak, the number of persons stricken with the disease might have been considerably less.

In general, boards of health which are efficient and active have been found ready to confer and to act promptly regarding the abatement of nuisances. On the other hand, some of the less efficient boards resented having their attention called to the nuisances, and failed to carry out suggestions made by the State Inspectors of Health.

In some localities it was discovered that the boards of health were hindered in their work by the lack of a sufficient number of inspectors or by the absence of sanitary police to enforce rigid regulations.

In minor instances the State Inspectors of Health were consulted personally or by telephone concerning a great variety of complaints, the majority of which were promptly remedied by reference to or communication with the proper authorities.

A brief description, including location, of the nuisances investigated by the State Inspectors of Health and reported to the local health authorities, and the action taken by said authorities concerning their abatement, is as follows: —

NUISANCES.

Description.	*Action taken.*
Abington. — An overflowing cesspool.	Cesspool cleaned.
Amesbury. — Filthy privies and accumulations of offal and refuse (called to the attention of the board of health on several occasions).	In some instances the privies were cleaned, and the refuse removed.
Amherst. — Accumulation of manure from badly kept stables.	No effective action.
Ashburnham. — A recently constructed cesspool dangerously near a well used for drinking water.	Use of cesspool discontinued; course of drainage changed; another cesspool built.
Unsanitary condition of drains in different sections of the town.	Matter pending.
Faulty drainage conditions on the premises of several residents.	Improvements made in two instances.
Athol. — Unsanitary conditions existing upon the banks of Millers River in a thickly settled section of the town.	Matter pending.
Collection of night soil in open receptacles, and its disposal uncovered on land near several residences.	Nuisance abated.
Filthy conditions and faulty drainage on land.	Matter pending.
Beverly. — Accumulation of the contents of several cesspools.	Nuisance abated.
Overflowing cesspool.	Nuisance abated.
Boston. — The dumping of street sweepings and manure on a vacant lot adjoining residences.	It was found at the office of the board that action had already been taken in the matter, and that orders had been issued to abate the nuisance.
Insufficient surface drainage of a playground in Charlestown. The State Inspector of Health recommended the installation of drains connecting with the sewer.	Drains were installed connecting with the sewer.
Conditions of overcrowding in a basement in East Boston, where a family of six lived in one small room.	Matter pending.
Bourne. — An overflowing cesspool located on the grounds of the Bourne High School.	Nuisance abated; cesspool cleaned.

Description.	*Action taken.*
Brockton. — The filter beds at the Brockton Hospital, being a menace to the community, the State Inspector of Health urged the sewer department to extend the sewer to the hospital. This was also urged by the hospital officials.	Nuisance abated; sewer laid.
Unsanitary conditions in the cellar of a stable.	Conditions made sanitary.
An overflowing cesspool.	Nuisance abated; sewer connection.
Buckland. — Offensive covered brook sewer which overflowed at times.	Plans made for abatement.
Cheshire. — The inspector was consulted by the board of health concerning conditions about a pigpen and house drainage.	Conditions improved.
Chicopee. — Filthy privy vault in the basement of a factory.	Nuisance abated; new sanitary water-closets and toilet rooms provided.
An uncovered manure pile in a stable yard, near a tenement.	Nuisance abated; a covered receptacle provided.
Offensive odors from a rendering establishment.	Conditions improved.
Concord. — Canal bed more or less filled with mud, decaying wood and old shingles, that might give off considerable odor at times.	Agent of the property promised to make the locality sanitary.
Dana. — Swampy and undrained land.	Matter pending.
Dartmouth. — Obstructed water courses in Cove village, Dartmouth, near the New Bedford line.	Marked abatement and progressive improvement.
Dedham. — Filthy surroundings and improper disposal of body waste in a section of the town used as a sort of a camping ground during the summer season.	Some improvement of conditions secured.
Deerfield. — Undrained land.	Nuisance abated.
A foul brook near the center of South Deerfield.	Conditions improved.
Essex. — A neglected privy vault in South Essex; the State Inspector of Health recommended that it be put in sanitary condition.	Undetermined.
Fairhaven. — Open ditch or drain through private land at the intersection of certain streets.	Matter finally found its way to the attorneys for the town, and conditions remain about the same.

Description.	*Action taken.*
Gloucester. — Large sink drains overflowing on premises in East Gloucester.	Nuisance abated.
Unsanitary privies; an overflowing cesspool; faulty drainage; an open sink drain, and garbage thrown on the ground.	Conditions remedied.
Unsanitary conditions on certain premises.	Conditions remedied.
An overflowing cesspool.	Nuisance abated; cesspool cleaned.
Great Barrington. — Alleged unsanitary conditions in a building used as a tailor shop.	Conditions not found as represented.
Groton. — Badly constructed and poorly kept privies, and overflowing sink cesspool which filled the gutter for about 25 feet beside the street near a large tenement block and public hall.	Unreported.
Groveland. — Sewage matter in a brook in the rear of premises.	Board of health considered action in the matter unnecessary.
Hamilton. — Unsanitary conditions at a stable. State Inspector of Health suggested that the stable be properly drained and that the accumulation of manure be prevented.	Conditions improved.
Unsanitary conditions of certain privies.	Unreported.
Haverhill. — Domestic fowls and animals.	Board of health ordered premises to be maintained in proper condition.
Standing water on street.	Board of health investigated nuisance, but stated that for legal reasons they were unable to proceed in the premises.
Barn.	Nuisance abated; barn cellar cleaned out.
City dump.	Nuisance abated by the board of health acting with the municipal council.
Odors arising from a catch-basin in Bradford district.	Nuisance abated; catch-basin trapped.
Sewage in an open brook in the Ward Hill district of the city.	No action taken.
Sewer opening at the foot of a street.	Municipal council stated that city government intended to reconstruct sewer.
Holyoke. — Filthy privy vault used by tenants of a block and by the public.	Nuisance abated.

Description.	*Action taken.*
Hull. — Scum which accumulated on Straits Pond during the hot weather.	Nuisance abated by employing a man to remove the scum daily.
Ipswich. — Privies in relation to an outbreak of typhoid fever.	No action taken.
Lenox. — A cesspool and house drainage. State Inspector of Health advised board of health as to the course to pursue.	House drainage nuisance abated; cesspool nuisance not abated.
Leominster. — Horse bedding spread on a rack in very close proximity to a neighbor's pantry window.	Matter pending.
Lexington. — Low places with stagnant water much polluted, in a comparatively thickly settled district; places found in looking up a case of diphtheria on the border line between Arlington and Lexington.	Result not stated.
Lowell. — Large beam house near center of city; very old plant; buildings and ground thoroughly saturated with odors; buildings so constructed that they cannot be kept clean throughout; away from the tannery plant, and stock and sewage not so handled as to be least objectionable to the public. Two stories of the building recently collapsed.	Co-operated with the board of health, which has declared the place a nuisance; officers of the tannery asking for a location on which to build a new plant.
Lunenburg. — Filthy pigpens near a thickly settled section of the village.	Nuisance abated.
Water-closets for males in Whalom Park.	New water-closets for males constructed.
Swampy land and mud hole, water of which used for watering cattle. (Matter pending since 1907.)	Drainage improved.
Lynn. — Swill box on premises.	Conditions such that it was deemed unwise to bring the matter to the attention of the board of health.
Unsanitary conditions in and near a brook; number of privy vaults found in very unsanitary condition; large cesspool connected with bakery objectionable, as it allowed the flow of sewage into a brook. Also connected with the bakery was a privy box on top of the ground, with boards removed, allowing ready access to flies. No screens on windows or doors of bakery. A wide-open cesspool in rear of one of the houses.	Conditions improved as far as practicable at present. Recommended that the municipal sewer be extended to relieve these conditions, but at the present time the authorities are unable to do this.

Description.	*Action taken.*
Malden. — Swill and ashes not properly confined in a receptacle.	Board of health ordered yard cleaned, and requested the owner of premises to keep it clean.
An overflowing cesspool, the water flowing into the street gutter after a severe rain; no sewer in street; house located under steep hill.	Unreported.
Manchester. — Unsanitary conditions of Central Pond due to large amount of domestic sewage draining into it.	Eight hundred dollars appropriated by selectmen to improve conditions, but further attention is needed.
Mansfield. — Filthy pigpen.	Nuisance abated.
Medford. — Hens kept without permit; eight hens kept in small building, and at the time of inspection conditions appeared to be entirely satisfactory for such a purpose.	The board of health was notified, and subsequently a permit was issued to the parties desiring it.
Keeping of hens; 20 hens and 50 chickens in a yard 30 by 25 feet, and a hen house 8 by 20 feet.	The owner was requested to remove the hens.
Merrimac. — Open ditch carrying sewage matter.	Ditch tiled, and nuisance abated.
Methuen. — Piggery.	Nuisance abated.
Montague. — Eight privy seats within 30 feet of each other; opportunity for sewer connection.	No action reported.
Newbury. — Piggery.	Complaint unjustified.
Newburyport. — Sewage matter in a drain.	Board of health acknowledged the existence of nuisance, but stated inability to fix responsibility.
North Adams. — State Inspector of Health consulted concerning proposed location of a cesspool.	Proposed location of cesspool changed so as to avoid possibility of a nuisance.
North Andover. — Overflowing cesspools and improper drainage in a tenement block.	Nuisance abated; premises connected with sewer.
Drainage nuisance, which might be remedied by the building of a proper cesspool.	No action taken.
Sewage in a surface drain.	No action taken.
Northfield. — Bad privy and flies in connection with garbage.	No effective action taken.
Norwood. — State Inspector of Health upon request of board of health investigated with them nuisances consisting of overflowing cesspools.	Nuisances abated; board carried out State Inspector's of Health recommendation.

Description.	*Action taken.*
Otis. — Offal spread upon a field, preliminary to ploughing. Field partly ploughed; odor much less than several days earlier.	Nuisance abated; ploughing completed.
Oxford. — Cesspool.	Nuisance abated.
Palmer. — Filthy pigpen in a residential section. Owners of pigs put cow manure into pen, thus adding to the already filthy condition.	Board acted promptly, ruling that no pigs should be kept in family neighborhoods during the summer months.
Plainville. — On request advised with the board of health as to the best method to pursue to secure the abatement of nuisances caused by the discharge of sewage into a running brook.	Nuisances abated.
Quincy. — Manure from a large flock of hens and a dead horse on premises in South Quincy.	Nuisance abated.
Foul odors from a large stable in the residential district.	No decisive action.
Two overflowing cesspools, discharging contents into the middle of the street and causing much annoyance and nuisance to residents on street. State Inspector of Health recommended immediate action.	Nuisance not abated.
Revere. — Manure pit in stable connected with a hotel.	Nuisance abated.
Overflowing cesspool, causing an offensive stream to run down a public street.	Nuisance abated.
Overflow from several cesspools, causing a foul stream and a stagnant pool on a vacant lot.	Nuisance abated.
Offensive stagnant pool caused by a sink drain and a dirty, offensive privy vault.	Nuisance abated.
Rockport. — Unsanitary drainage conditions of certain houses. Several brooks and one beach polluted with sewage.	Conditions greatly improved.
Russell. — Filthy conditions of yards about homes where typhoid fever existed, such as filthy pigpens and stable yards, and generally untidy conditions.	Nuisances abated.
Salisbury. — Overflowing sewers at Salisbury Beach.	Construction of sewerage system at this resort such that condition is difficult to remedy.
Accumulation of clam offal at the ferry slip at Rings Island.	No action taken.

Description.	*Action taken.*
Saugus. — An objectionable manner of disposing of contents of privies and cesspools on a farm.	Conditions improved by shovelling dirt over the deposit and ploughing it into the ground as soon as possible.
Scituate. — Privy contents deposited close to a neighbor's well, in North Scituate.	Privy contents removed, and nuisance abated.
Sheffield. — State Inspector of Health, with the board of health, visited two tenements concerning which complaint had been made. The houses were dilapidated, dirty and in thoroughly bad condition; privies in bad condition and too near highway.	Privies were moved back from the street.
Shelburne. — Exhaust gas from an engine was discharged so as to be offensive to neighboring inhabitants.	Use of engine discontinued.
Privies emptying into a brook in the center of the town.	Conditions improved.
Foul privy.	Nuisance abated.
Springfield. — Filthy cellar in unfinished house; laborers polluting the cellar. (It was found that of the children who had been playing in or near the cellar, 4 had anterior poliomyelitis.)	Nuisance abated.
Stoneham. — Foul odors coming from the remains of a barn burned; offensive odor, probably from cellar which contained stagnant water.	Premises immediately cleaned.
State Inspector of Health, at request of the board of health, visited a piggery and found it to be unsanitary.	Nuisance abated.
Swansea. — Discharge of water-closet material and sewage accumulation into a tideway, passing through private land, near the railroad station at Touisset.	In opinion of the local board, the condition found did not constitute a nuisance.
Templeton. — Rubbish dumped upon private land in a thickly settled section of the town.	Owner of the land notified to prohibit dumping of rubbish upon the land.
Tyngsborough. — Many nuisances at Lakeview and Willowdale parks, which were contaminating the source of water supply for both resorts and many summer cottages.	New water-closets were recommended and installed at Lakeview Park.

Description.	*Action taken.*
Wakefield. — Large 12-tenement block not connected with the sewer; from 65 to 70 persons lived in the block; outside privies provided, located about 30 feet in rear of the block; these were cleaned out but once a year. In addition, swill, ashes, tin cans, broken bottles and other refuse found in the back yard.	Provisions made for connecting the block with public sewer.
Williamsburg. — Foul, open sewer.	Conditions improved.
Williamstown. — Offensive odors and conditions due to pigpen.	Pigs removed, nuisance abated.
Winthrop. — Manure pit in a stable connected with a hotel.	Nuisance abated.
Worcester. — Unsanitary conditions existing in the rear of premises.	Nuisance abated.
An overflowing cesspool.	Nuisance abated; new cesspool constructed.

SANITATION OF SCHOOL BUILDINGS.

Many schoolhouses were visited during the year in connection with the investigation of the use of the common drinking cup.

Aside from this investigation 254 schoolhouses in 10 cities and 55 towns were inspected, as follows: —

Abington,	3
Acushnet,	3
Amesbury,	1
Ashburnham,	1
Ashby,	1
Athol,	3
Auburn,	1
Barre,	2
Berkley,	2
BEVERLY,	1
BOSTON,	1
BROCKTON,	8
Chester,	1
Clinton,	5
Cohasset,	1
Dartmouth,	7
Deerfield,	1
Dighton,	6
East Bridgewater,	2
Fairhaven,	2
FALL RIVER,	21
FITCHBURG,	17
Freetown,	4
Gardner,	6
GLOUCESTER,	1
Great Barrington,	1
Hardwick,	2
Hubbardston,	1
Hull,	1
LAWRENCE,	12
Leicester,	3
Leominster,	6
Lunenburg,	2
Manchester,	1
Marion,	5
Mattapoisett,	3
Middleborough,	2
Millbury,	2
Monroe,	1
NEW BEDFORD,	19

New Braintree,	1
North Andover,	1
Oxford,	3
Palmer,	1
Phillipston,	1
Plymouth,	2
Princeton,	1
Rehoboth,	5
Rochester,	2
Royalston,	2
Rutland,	1
Salem,	2
Seekonk,	8
Sheffield,	1
Somerset,	4
SPRINGFIELD,	3
Stockbridge,	1
Swansea,	6
Templeton,	3
Westfield,	2
Westminster,	1
Westport,	10
Weymouth,	2
Whitman,	3
WORCESTER,	26

Detailed reports were submitted at the time of inspection.

Special comments upon certain schoolhouses, together with recommendations and results secured, are given below: —

Name of School and Special Conditions noted.	*Results.*
Acushnet. — Special report submitted.	No action.
Beverly, Washington School. — Building unsatisfactory.	Appropriation of $80,000 for a new building.
Boston, Prescott School. — Improperly heated and ventilated, unclean, lack of fire escapes.	Building altered, rooms cleaned and painted, new heating and ventilating systems installed.
Deerfield. — General poor condition of the building. Advised not to use the building.	No action.
Gloucester, St. Anne's Parochial School. — Poor toilets.	New toilet accommodations installed.
Lawrence, Newbury Street School. — Building dark, unventilated, very dirty; closets filthy. Building swept once a week, washed once a year.	No action.
Manchester, Prince Primary School. — Ventilation inadequate.	Action undetermined.
Marion. — Special report submitted.	No action.
Mattapoisett. — Special report submitted.	No action.
Quincy, Wollaston School. — Overcrowded, ventilation unsatisfactory, lighting poor.	Appropriation of $75,000 for new building.
Salem, Pickering School. — Results of investigation as to ventilation were used as argument to secure additional room.	Additional accommodations now building.
St. John's Parochial School. — Unsuitable for the purpose, and crowded.	Extensive changes made and additional room secured.

Name of School and Special Conditions noted.	*Results.*
Springfield, One School. — Light too intense, from lack of window shades. Matter brought to attention of city property committee.	Undetermined.
Westport. — Special report submitted.	No action.
Westfield, Mundale School. — Poor light, poor closets.	Improvements made.

In 1 instance where there was danger of fire from a furnace located under a stairway, the location of the furnace was changed.

In 3 instances where old buildings were condemned, new buildings are under construction.

In 6 instances out of 8, where the lighting of schoolrooms was poor, conditions were improved by freshly tinting the walls.

Overcrowding was noted in 6 instances.

In 27 instances closets were noted as being poor or unsatisfactory, on account of insufficient ventilation, lack of care, or because they were too small.

In 4 instances school privies were improved.

In 11 instances ventilation was inadequate.

One State Inspector of Health, discussing the subject of ventilation, stated that there was a striking lack of moisture in the air of schoolrooms. The pupils would be more comfortable with a less degree of heat were there suitable provision for moisture in the air of the schoolroom. It should not be difficult to secure this in some way, as is often done in private houses, through a receptacle holding water connected with the air supplied to the rooms, or through steam supplied from pipes opening into the fresh-air supply.

Tests for CO^2 were made in four school buildings in Lawrence in the same manner and with the same apparatus as corresponding tests in weave rooms of cotton mills. The average of 16 tests in schoolrooms gave 18 parts CO^2 per 10,000, which represented an average of 6 parts of CO^2 per 10,000 more than was found in the weave rooms of the cotton mills.

COMMON DRINKING CUPS IN SCHOOLS.[1]

During the year the subject of common drinking cups in schools was brought to the attention of school committees, school superintendents and other interested authorities, by letters, personal conferences and by the distribution of a pamphlet upon the subject supplied by the State Board of Health.

Results began to appear almost immediately from the experimental installation of mechanical drinking devices in the schools of many cities and towns where the presence of a public water supply made the use of such devices possible. In other schools increased attention was given to the use and care of individual cups. In many instances the pupils bring their own cups, and the teachers are urged to see that they are kept clean.

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[1] The law prohibiting the use of common drinking cups under conditions to be prescribed by the State Board of Health did not become effective till Oct. 1, 1910.

In one district, out of a total of 138 schools 39 are provided with drinking fountains.

MATTERS RELATING TO WATER SUPPLY AND SEWERAGE.

During the year various water supplies, both public and private, were inspected. The inspections were made at the request of the State Board of Health of the local authorities or in the course of investigations of diseases dangerous to the public health.

Inspections with reference to sewage disposal were made largely in connection with the investigation of nuisances, though sometimes when investigating communicable diseases, or at the request of parties concerned.

Thirty-three such inspections were reported, more or less in detail, as follows: —

WATER SUPPLIES.

Cheshire. — The public water supply was inspected and a special report was submitted to the State Board of Health calling attention to certain sources of pollution, affecting particularly one source of supply.

Dartmouth. — There was considerable correspondence relative to the water supply at Lincoln Park. Changes at the wells and in the pipes were made, and the tanks were cleaned. A new source of supply, which will do away with all complaints, is under consideration.

Georgetown. — An examination of the well on the premises of Mr. G. Ross was made, to ascertain whether the water from the well was the cause of sickness in members of the family. Apparently the water had nothing to do with the sickness.

Hyde Park. — Conferences were held with the local board of health concerning the water supply, and it was pointed out that the quality of the drinking water, as shown by analysis, was growing steadily poorer. At the close of the year the subject received additional consideration because of a considerable outbreak of typhoid fever, for which no other cause could be found save the poor quality of water supplied. At this time the local board of health issued a circular in several languages and distributed the same from house to house, urging that all water used for cooking or drinking purposes should be boiled.

Lee. — The Laurel Lake supply in Lee was inspected and a special report was submitted to the State Board of Health.

Methuen. — Owing to the presence of typhoid fever in a family in town, the premises were visited to determine the advisability of an analysis of the well water used. The well was apparently not even a remote cause of the two typhoid cases.

Montgomery. — Sickness, reported to be typhoid fever, on the Fomer watershed, led to an inspection of this source of supply. There were 9 cases of illness, most of which were at a farmhouse or in wood choppers' camps located on the watershed, near springs or brooks which found their way into this source of supply. There was pollution also from employees of a small sawmill. The possibilities of pollution were called to the attention of members of the Montgomery board of health who were present at the time, and they were urged to see that the nuisance was abated. This they agreed to do.

Of the 9 cases of illness, the first was a young man of twenty-two, who felt badly for several weeks, but no physician was called. The second case, a young man of twenty-one, returned to his home in Huntington, where he died of anterior poliomyelitis. The third case, a man of thirty-three, was removed to a hospital in Westfield, where he died, supposedly of a mild typhoid fever. The fourth case, a boy of sixteen, brother of the first case, was removed to Russell, as was also the fifth case, a boy of fourteen, both supposed to have typhoid, both recovering. The sixth case, brother of the preceding, taken ill soon after, was also removed to Russell, and recovered after a long illness. The seventh case, a girl of fourteen, sister of cases one and four, was taken ill in Russell, after taking care of her brother, and died after an illness of two weeks. Cases eight and nine, mother and brother, respectively, of cases one, four and seven, were also supposed to have typhoid fever, and recovered. Widal tests were taken in 5 of the 6 cases which recovered, and in every instance were negative. This, coupled with the fact that one of the patients died of anterior poliomyelitis, would seem to throw some doubt upon the diagnosis of typhoid.

Pittsfield. — A private source of water supply at the junction in Pittsfield was inspected and a sample taken for analysis. The water was supplied to the railroad and to about 90 families. Nothing objectionable was found.

Rowley. — An examination of the well on certain premises where typhoid fever existed, and an analysis of the water from the well, showed that it was polluted.

Salem. — Water from a farm in town, upon analysis, was found polluted, and its use was forbidden.

Somerset. — The necessity for a public water supply is urgent. The subject has received attention, hearings have been held, and petitions have been sent to the Legislature. The matter is still under consideration.

Springfield. — An inspection of the Little River system of water supply was made by the State Inspector of Health, accompanied by a member of the engineering department of the State Board of Health. Conditions were found satisfactory, all precautions having been taken to prevent possible pollution of the supply.

Westport. — Search is in progress for a suitable source of water supply for the village and factory of the Westport Manufacturing Company, in accordance with a recommendation of the State Board of Health.

DRINKING WATER IN MILLS.

As a result of suggestions, quantities of galvanized iron pipe were used to convey drinking water to departments in cotton mills; water barrels in a considerable number of mills were thoroughly cleaned and supplied with covers, faucets and drinking cups; glasses for individual use were furnished many operatives in mills; galvanized iron pails with covers have replaced many old wooden buckets as receptacles for drinking water; and water carriers have been added to the usual force in mills.

SEWERAGE MATTERS.

Amesbury. — The attention of the citizens and of the local board of health was called to the necessity for a proper system of sewage disposal in the town. At a town meeting in March (1910) the subject was presented, and by vote the matter was indefinitely postponed.

Brockton. — The town of East Bridgewater entered a complaint concerning the pollution of Trout Brook and Salisbury Brook in the city of Brockton. The pollution came from a manufacturing plant. This company is now installing a system of purification for its sewage, so that it will not be discharged into the brooks loaded with tannin and other by-products.

Chicopee. — A sewer was constructed, upon request, so that proper closet and toilet facilities might be installed in a foundry connected with an agricultural tool company.

East Bridgewater. — The attention of the local board of health was called to the pollution of Salisbury Brook by sewage near Shaw's store.

Ipswich. — An outbreak of typhoid fever in the town was the occasion for again calling attention to the condition of privies and the badly polluted condition of brooks in the center of the town, and emphasizing the necessity for a proper system of sewage disposal, which had been previously recommended.

Lynn. — Conditions on Nahant Road, Washington Street and Wave Street, a section of the city without sewers, were examined. The land is very low, for the most part almost on a level with the ocean. During extraordinary conditions of the tide, such as prevailed on Dec. 26, 1909, the tide-water filled the cesspools, and in one instance the contents of the cesspool backed up into the set tubs and the closet in the cellar. The matter was taken up with the local board of health and it was recommended that proper sewage facilities should be provided for this district. Subsequently, an appropriation was granted, and proper sewers built.

Manchester. — The conditions in Central Pond and other parts of the town were brought to the attention of the selectmen, who were urged to provide proper sewage facilities. A committee was appointed to investigate and to determine the best method and the probable expense of providing such facilities, and the sum of $1,000 was appropriated for the expenses of making such an investigation.

Merrimac. — A considerable amount of sewage running in an open ditch in the center of the town, and similar conditions elsewhere, point to the installation of a proper sewerage system as a practical remedy for the present conditions. The tiling of a portion of the ditch in the center of the town has partially abated the nuisance caused by the proximity of the ditch to dwellings and manufacturing establishments.

Newburyport. — In a certain section of the city, which has long had a higher typhoid fever rate than the rest of the city, the sanitary conditions were brought to the attention of the local board of health, with the result that filthy privies were cleaned and some premises were connected with the sewer. Much more, however, should be done to place the section in proper sanitary condition.

Salisbury. — Unsanitary conditions arising from the absence of a proper sewerage disposal system at Salisbury Beach were brought to the attention of the local board of health.

Westfield. — The local board of health was requested to secure the construction of a sewer, so that proper closet and toilet facilities might be provided in a large foundry. The matter will be brought up at the coming town meeting.

Williamstown. — A complaint as to the pollution of the Hoosick River was investigated and found to be well founded. The pollution was more pronounced than usual, on account of the very low stage of water in the river.

SANITATION OF FACTORIES AND WORKSHOPS.

The powers and duties of the State Inspectors of Health relating to the protection of the health and welfare of persons employed in factories, workshops and other similar establishments may be outlined as follows: —

1. To enforce the law that employees shall be provided with fresh and pure drinking water.
2. To enforce the acts relative to the purity and use of water for humidifying purposes, and the act regulating the humidity and temperature of the atmosphere in textile factories.
3. To assist the State Board of Health in the enforcement of the law relative to sewerage, drainage and sewage disposal affecting manufacturing or other corporations or individuals.
4. To assist the State Board of Health in the enforcement of the laws relating to the carrying on and restraint of offensive trades or occupations.
5. To enforce the law requiring proper cleanliness, ventilation and lighting in factories and workshops (including foundries).
6. To order installation of appliances to remove dust, gases, vapors, odors and other impurities for the protection of the health of the employees.
7. To approve means of removing dust caused by grinding on emery and buffing wheels, and to enter and inspect factories concerning which complaint is made that proper appliances are not provided.
8. To enforce the law which prohibits impure or foul odors from water used for humidifying purposes (*cf.* 2).

9. To enforce the law which provides for proper water-closets for both sexes, and the law which provides for giving notice to the board of health of the city or town in which a factory or workshop is situated in case of defective sanitary arrangements, nuisance or other matter not by law remediable by the State Board of Health.

10. To enforce the law relative to washing facilities and water-closets in foundries, and to assist the State Board of Health and the local board of health in the enforcement of laws relating to sewerage applicable to foundries, to which the statute relating to the sanitary provisions in foundries does not apply.

11. To assist the local boards of health in the enforcement of the law relative to the requirement of medical and surgical appliances in factories or shops.

12. To assist the local boards of health in the enforcement of the law requiring receptacles for expectoration in factories and workshops.

13. To notify manufacturers and to recommend changes because of overcrowding in a factory or workshop.

14. To notify manufacturers and recommend changes because of the exposure of employees to an avoidable degree of heat or to avoidable indoor dampness (aside from excessive artificial moisture in the textile industry).

15. To enforce the law relative to providing seats for women employees in manufacturing establishments.

16. To enforce the law relative to the hygiene of factories and workshops where clothing is manufactured.

17. To see that local authorities do not permit persons found in factories ill with tuberculosis or other diseases dangerous to the public health to be neglected or improperly cared for, and to advise and assist local authorities in the enforcement of quarantine in such cases for the protection of the public.

18. To report to the proper local health authority every case of disease dangerous to the public health discovered in factories and workshops where clothing is manufactured.

19. To co-operate with local health officials in gathering all information possible concerning the prevalence of tuberculosis and other diseases dangerous to the public health in factories and workshops, and to take such steps as, after consultation with the local authorities and the State Board of Health shall be deemed necessary for the protection of the public.

20. To co-operate with local health officials in matters relating to water supply and sewerage (including the connection of factories with public sewers) (*cf.* 1, 2, 3).

21. To notify the proper local health authority of any nuisance existing in or about any factory or workshop.

The absence of statistics relative to the health inspection of factories and workshops is due to the adoption of an entirely new system of keeping factory records. The reason for making the change is to secure greater uniformity in the tabulation of the work of the State Inspectors of Health. The change from the old system is now in progress, so that at the end of the first five-year period statistics relating to all important aspects of the work will be available. This new system ensures accuracy in obtaining statistics; it relieves the inspectors of considerable clerical work; and it enables the State Board of Health to direct the field work in as systematic and economical a manner as the statute provisions permit. The new record system includes a monthly summary of the work accomplished by each State Inspector of Health, and the total amount accomplished by all the inspectors. These facts are recorded in a progressive table, giving a summary of the work throughout the State up to date.

The next annual report will contain a complete record of the number of inspections made in industrial establishments, the number of orders issued and the number complied with during the year.

In the enforcement of the laws relating to the sanitation of factories and workshops, the State Inspectors of Health have aimed to do thorough work, even though this involved visiting a smaller number of establishments than otherwise might be visited. It must be borne in mind that the chief value of the service to persons who work in industrial establishments, and to the community, does not lie in routine or systematic inspection, but in the changes which give rise to better sanitary conditions, and in the introduction of methods to protect more efficiently the health of the workers from injurious influences. In fact, the essential purpose of inspecting the sanitary conditions in industrial establishments is to safeguard the health, first, of the workers, and second, of the community at large. It has been the custom of the inspectors to make a careful study of all the influences in a given establishment which may be injurious to the health of the workers. Such a study has involved a knowledge of the sanitary conditions, including the adequacy of light, ventilation and cleanliness of the establishment, as well as some knowledge of the various industrial processes in which the operatives were engaged. This work in every instance has led to practical results; if any unsanitary conditions were found, if any processes were conducted wherein employees were exposed to injurious influences, orders were issued, and, if no specific statute covered the case, recommendations were made to provide for the necessary changes.

When determining whether the conditions affecting the health or welfare of the working people in any factory or workshop were in accordance with the law, and the law did not specify the standard of such conditions, the State Inspectors of Health used as standards the conditions which they found existing in those factories and workshops carrying on similar business in similar buildings within the Commonwealth where the health and welfare of the working people were most completely protected. Often many visits to an establishment were necessary therefore in order to bring that establishment up to as high a standard of sanitary efficiency as was found to exist in those buildings wherein persons engaged in similar work were best protected. Once the desired changes were made in a particular building, frequent visits were no longer necessary. It thus happened that some establishments were inspected a number of times during the year, while others were not visited at all.

Cleanliness.

In the enforcement of the laws relating to sanitation, and in looking for conditions which might be injurious to the health of the operatives, the State Inspectors of Health had in many cases no legal standards to work with. The law relating to cleanliness, for instance, provides that "all factories and workshops shall be kept clean," but leaves to the judgment of the inspector the question of determining what constitutes a sufficient degree of cleanliness. The nature of the work carried on in any particular establishment has, of course, to be taken into consideration; the degree of cleanliness which would be considered satisfactory in one kind of industry might be considered entirely unsatisfactory in another. The standard of cleanliness, for example, in foundries, machine shops and chocolate factories, cannot be the same.

The way in which the State Inspectors of Health applied the general statutory provisions was to keep in mind the standards found to prevail in the best establishments carrying on business under similar conditions in any particular industry, and to order improved conditions whenever it appeared that the standard of cleanliness was below what might be considered practical. In general, a markedly improved condition of cleanliness was found in the industrial establishments visited during the year. The number of orders that it was necessary to issue in order to improve cleanliness was less than in previous years. Factory superintendents, as well as the operatives, seemed to have acquired a more intelligent realization that careless spitting, for instance, was a revolting habit, and often a menace to health. Many factories were found comparatively free from this objectionable condition. In a number of instances orders requiring higher standards of cleanliness were issued, and the conditions were consequently improved.

Ventilation.

Careful attention was given during the year to the ventilation of industrial establishments. Whenever the condition of the air of the rooms was deemed to be injurious to the health of the operatives, orders for improved ventilation were issued. There were many factors which rendered ventilation inadequate; in many instances the conditions could be remedied, while often they were unavoidable because they were rendered necessary by the processes involved. In a considerable number of establishments, including shoe and jewelry factories, ventilation was found inadequate because of the great number of benches, presses, racks and appliances necessary for the trade, allowing too little air space per capita, and interfering with the free circulation of the air of the room. In this connection, attention should again be called to the loose phraseology[1] in the existing law relating to ventilation.

For example, section 94, chapter 514 of the Acts of 1909 (An act to codify the laws relating to labor), after providing for guarding belting, shafting, gearing and drums, disposes of the important subject of ventilation in the following words: "All factories and workshops shall be well lighted, well ventilated and kept clean, and this requirement shall be enforced by the state inspectors of health," but does not provide any standard by which the adequacy of the ventilation shall be measured.

Again,

Section 83 of chapter 514 of the Acts of 1909 would appear to go somewhat further, but it requires no extended examination to reveal its defects. It provides as follows: "A factory in which five or more persons and a workshop in which five or more women or young persons are employed shall, while work is carried on therein, be so ventilated that the air shall not become so impure as to be injurious to the health of the persons employed therein and so that all gases, vapors, dust or other impurities injurious to health, which are generated in the course of the manufacturing process or handicraft carried on therein shall, so far as practicable, be rendered harmless;" but it stipulates nothing as to the processes which shall be followed in rendering these gases, vapors and other injurious impurities harmless.

The next section of the same chapter reads as follows: "If, in a workshop, or factory which is within the provisions of the preceding section, any process is carried on by which dust is caused which may be inhaled to an injurious extent by the persons employed therein, and it appears to a state inspector of health that such inhalation would be substantially diminished without unreasonable expense by the use of a fan or by other mechanical means, such fan or other mechanical means, if he so directs, shall be provided, maintained and used." In this section there is nothing to indicate who shall be the judge of whether dust is inhaled to an injurious extent; and even though it be determined that the dust is so inhaled, there is no provision for remedying the condition, unless it shall appear that the danger may be substantially diminished without unreasonable expense.

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[1] *Cf.* Senate No. 27, January, 1905, report of the State Board of Health, under resolve 99 of the Acts and Resolves of 1904, pp. 13–17 inclusive.

Attention is called, therefore, to the recommendations of the State Board of Health to the Legislature of 1905, namely, as to "the desirability of the codification of all laws relating to industrial pursuits and sanitation of factories and workshops after the manner of the British factory acts, of a more explicit phraseology, and of the establishment of standards of ventilation efficiency."

Excessive Heat and Moisture. — In certain departments of a bleaching establishment, as a necessary component of the processes carried on there, the air was overheated, in spite of the fact that fans were constantly in operation. In the "making room" of a shoe factory the air was hot and the ventilation poor, notwithstanding the use of fans. In the braiding room in a shoe lace factory the employees were exposed to excessive heat on account of the proximity of the room to another room, in which a temperature of 110° Fahrenheit was maintained. In several jewelry factories the ventilation was impaired by the excessive humidity caused by steam from the "washing off" benches. Excessive heat and moisture were found in the glazing, cutting, steaming and bending departments of several chair factories. Likewise, in a straw hat factory some of the employees were unavoidably exposed to excessive heat, due to the nature of the work.

A special study of the regulation of heat and moisture in textile factories was begun.

Inadequate Removal of Products of Combustion. — In several iron working shops the air of the room was vitiated by steam and smoke from forges, — a condition which seemed unavoidable. In the making rooms of several large shoe factories the air was vitiated by smoke and gases from the heel-finishing machines. In two attics used as press rooms in a printing establishment the air was foul and suffocating; the floor below was heated by coal stoves, and all the foul air from this floor escaped through the open stairway into the attics.

Inadequate Removal of Gases and Vapors. — The air of the bronzing room of a brass machine shop was found vitiated by acid fumes. In three jewelry factories, in spite of ordinary precautions, objectionable conditions were created by the lacquer fumes. In the paint and varnishing rooms of many wood-working establishments a strong odor of paint and varnish was observed. In a factory where machine parts were manufactured, the room where small metal castings were dipped in acid solutions was a small low annex to the main building. It was poorly lighted by a dirty skylight, which was kept closed. There were a number of open vats containing sulphuric, nitric and hydrochloric acid. The room was filled with dense suffocating fumes, so that on entering one could not see whether there was any one there. As the result of the efforts of a State Inspector of Health the roof of this room was raised to twice its height, a large skylight was constructed, giving excellent light, and the vats of acid were heated and connected with flues leading to the roof. In many printing establishments the air of the rooms was vitiated by gases and fumes from monotype machines or from open melting pots. In all such cases orders were issued to hood the pots and connect them with exhausts. All such orders were complied with. A number of tests were made to determine the quantity of carbonic acid gas in the composition rooms of printing establishments. As a rule, it was found that where typesetting was done by hand only, carbonic acid gas was less than when typesetting machines were in operation. In one shoe factory and in one rubber factory employees were found exposed to the fumes of benzine and naphtha contained in open receptacles. In accordance with instructions closed receptacles were provided.

Removal of Dust. — Exposure to dust generated in the course of manufacturing processes, or caused by manual occupation, is a factor of great importance in the consideration of the effect of industry upon health. A special study was made by the State Inspectors of Health of buildings or parts of buildings where workers were exposed to poisonous or irritating dusts. Unless properly protected, persons so exposed are especially prone to diseases of the lungs. The constant irritation, caused by certain kinds of dust coming in contact with the mucous surface of the respiratory tract, makes one more susceptible to the invasion of disease-producing germs, especially to the tuberculosis bacillus. Unfortunately, many employees in industrial establishments do not realize the danger to which they are exposed, and consequently are indifferent to the use of protective appliances, if not actually opposed to their installation. For example, during the reinspection of the metal polishing establishments, which were examined the previous year, it was found that in some buildings wherein dust-removal systems were installed, upon the request of the State Inspector of Health, some of the employees refused to use the hoods provided for them, on the ground that the protective devices were unsafe or that they interfered with the work. Only in two establishments, however, were the hoods found inadequate, and in each instance an order was issued for the provision of a different hood. It was found that the refusal to use the protective devices provided was due to a lack of appreciation of the danger to which the employees were exposed. In several instances when manufacturers were requested to equip their emery wheels with hoods and blowers, they maintained that such equipment would be impracticable. In each instance it was noted, however, that the establishment was small, and that the owner had only one or two wheels in operation for short periods of time. Besides the irritating dusts there are processes which expose employees to poisonous dusts, such as lead and its compounds. In the case of lead, unless special precautions are observed the employees are likely to contract chronic lead poisoning. In the lead factories, or in establishments where lead is used to a considerable extent, there was a general lack of appreciation on the part of the employees of the dangers to which they were exposed. In some establishments respirators were provided for the employees, who, however, failed to use them, owing to the discomfort caused by their use. Even in an establishment where the employees handled lead powder respirators were rarely used.

Light.

In judging the efficiency of light in an industrial establishment, one must always bear in mind the kind of work done, for while light may be sufficient for one kind of work it may be entirely inadequate for more delicate operations causing a greater strain on the eyes. Even in processes where good light is not a necessary factor, the effect upon the worker of poor light is depressing and undesirable. As a rule, the processes requiring the most light were located near the windows. Poor light in many instances was due to the absence of natural light, but most often the light could be greatly improved by the whitening of the walls and ceilings and the cleaning of windows. The periodical whitening of walls and ceilings was found to exist only in the best regulated industrial establishments. In the greater number of establishments visited such periodical whitening was not a common practice. In one health district a considerable number of establishments were found that had not been whitened for twenty-five years or more. The walls and ceilings, therefore, were frequently covered with much dust, rendering the workrooms dark and dismal. The whitening of the walls and ceilings brought about in all instances most satisfactory results, — light and cheerful workrooms. The employees were invariably pleased with the change, a number having expressed themselves as being in better spirits as the result of it. The employers, likewise, including those who were loath to make the changes, were satisfied with the results. One employer, for instance, who undertook the whitening of the workrooms only when threatened that court proceedings would be instituted, not only was much pleased with the result, but stated that he was glad he had been forced to take such action.

Drinking Water Supply.

An investigation was made of the drinking water supply in every factory and workshop visited. In several establishments the water was found unfit for drinking purposes; in a few the water taps were not conveniently located for all the departments. In one instance the taps connected with impure water, intended for washing purposes only, were not so designated. In all the above instances orders or recommendations were issued to provide or facilitate a fresh water supply. In the city of Lawrence it was found that of the 48 cases of typhoid fever that occurred during the first three months of 1910, 34 of them were employees of one establishment. Suspecting that the artesian well water used for drinking purposes, or the occasional use of canal water, might have been a factor in the spread of the disease, the artesian water supply was diverted for humidifying purposes, and its place was taken by the city water supply. The canal water, intended for washing facilities only, was shut off except for one hour at noon and at night.

An outbreak of typhoid fever resulting from polluted drinking water in a factory in Fitchburg was investigated. A detailed account of this outbreak can be found elsewhere in this report.

Seats for Women.

As a rule, the industrial establishments visited provided suitable seats for women. Where no such seats were provided orders were issued requesting their installation. In several mercantile establishments where the number of seats were not sufficient, orders for additional seats were issued, and the seats were installed.

Water-Closets.

The conditions found to prevail in water-closets in factories and workshops showed, on the whole, a very marked improvement. This was to be expected from the numerous changes that had been made in water-closet conditions since the State Inspectors of Health took up the work. In addition to the installation of more than 1,000 new closets in some 200 establishments, several thousand other changes had been made in water-closet conditions. Consequently, during the present year a far smaller number of closets were found in unsanitary conditions. Orders requiring changes were issued in every instance where conditions were not satisfactory, and many of these orders have been complied with.

Sputum Receptacles.

Section 103, chapter 514 of the Acts of 1909, provides that "Suitable receptacles for expectoration shall be provided in all factories and workshops by the proprietors thereof, the same to be of such form and construction and of such number as shall be satisfactory to the board of health of the city or town in which the factory or workshop is situated."

The State Inspectors of Health, therefore, were ordered to report to the local board of health any violations of the above law.

The once prevalent habit of careless spitting has apparently diminished in many of the establishments visited. In all cases where no sputum receptacles were provided the attention of the proprietor was called to the lack of such provisions.

Medical and Surgical Appliances.

Section 104, chapter 514 of the Acts of 1909, provides that "Every person, firm or corporation operating a factory or shop in which machinery is used for any manufacturing or other purpose except for elevators, or for heating or hoisting apparatus, shall at all times keep and maintain, free of expense to the employees, such a medical and surgical chest as shall be required by the board of health of the city or town where such machinery is used, containing plasters, bandages, absorbent cotton, gauze, and all other necessary medicines, instruments and other appliances for the treatment of persons injured or taken ill upon the premises. A person, firm or corporation violating any provision of this section shall be punished by a fine of not less than five dollars nor more than five hundred dollars for every week during which such violation continues." As the result of an inquiry by the State Inspectors of Health in regard to the requirements of local health authorities in accordance with the provisions of this act, it was found that, (*a*) as a rule, too many articles were required, and that (*b*) essentials were often omitted and in their place were put articles which should not properly be included.

In order to insure more uniformity of action on the part of the local health authorities, and to prevent further misunderstanding of the law and the consequent lessening of its value, the State Inspectors of Health recommend a list of articles required by the local health authorities which is simple and practical, containing only essentials.

Whenever it appears to a State Inspector of Health that a proper first-aid outfit is not provided in a factory or shop he notifies the local board of health of the city or town in which the establishment is located.

Sanitary Conditions in Foundries in Massachusetts.

Two hundred and nine foundries, or all concerning which the Board had any knowledge, were inspected during 1910. Of this number, 163 establishments employed 10 or more workers and came under the provisions of section 102, chapter 514, Acts of 1909, while 46 employed less than 10 workers. A variety of processes are carried on in foundries.

These processes are of greater or less importance from a hygienic standpoint inasmuch as they expose the workmen to extremes of temperature, to dust and to more or less irritating gases and vapors.

Extremes of Temperature. — Many of the foundries were not properly heated, and during the cold days some of the workmen were said to experience considerable discomfort from the cold. In the immediate vicinity of the furnace, however, or during the time that the metal was poured, the heat was apt to be excessive.

Gases and Vapors. — In some foundries, in one of the districts, open coal fires were observed not connected with any chimney or drafts, and all the gases from the burning coal escaped into the foundry. In some iron foundries it was observed that in repairing the fire-clay lining of the pots, in which the molten iron is carried, wood was burned in them in order to dry the clay. The smoke from the burning wood escaped into the workroom.

In foundries where brass or composition is cast, employees are exposed to fumes from the zinc which enters into the composition of these metals. The metals are usually melted in fire pots which are most frequently below the floor. These are covered with iron covers so that during the melting few or no gases escape. In the foundries where the metal was melted the blast furnaces were found properly hooded to carry off the fumes. When the metal is ready for pouring, the crucibles are lifted out by means of long iron holders and are carried by two men to the molds where it is poured. It is during this process that the zinc volatilizes and is given off in dense gray fumes, which, on being cooled by the air of the room, precipitate into fine gray powdered flakes which fill the room and are unavoidably inhaled by the workers. Brass casters, as well as men who cast composition containing a high per cent. of zinc, frequently suffer from what is known as "brass chills." Those are more apt to suffer who are not used to this kind of work or who return to it after an intervening period during which such work was not done. The "chills" are apt to occur on damp, cloudy days, when the fumes, generated during casting, are not readily carried out of the foundry. The "chills" usually come on in the late afternoon or on reaching home in the evening. The worker experiences an irritation of the throat, a metallic taste in the mouth, and pains all over his body, as if suffering from an attack of "la grippe." Shortly after the "chills" set in they occur intermittently for a few hours and then terminate in a profuse sweat. Most often the worker feels well enough in the morning to return to work. Occasionally, however, a man may have to stay out of work for a day or two.

In iron and steel foundries there are no metallic vapors, but gases are generated when the metal is poured into the mold and when the casting is removed from the mold. The gases generate in the following manner: the cores which are made from different grades of sand are mixed with a "core binder" consisting of flour, sour beer, molasses, starch or some other sticky substance, to hold the sand together. The cores are often covered with a thin layer of powdered coal, so that when the metal is poured into the mold the layer of coal is ignited and a thin layer of gas is formed, preventing the metal from penetrating into the core and forming an uneven surface. The gases are generated, therefore, from the burning of the organic substances used as binders and from the layers of powdered coal. In addition to these gases there is considerable steam generated when the casting is dumped out into the mold, for the sand from which the mold is made is moist.

In steel casting men were observed to wear smoked spectacles, often two pair to protect the eyes from the intense heat, from the brilliancy of the molten steel, and from the sputtering of the metal.

Dust. — Great quantities of sand are used in the making of molds and cores. Floors, benches and the hands of operatives were covered with this sand dust.

The dry sand from which the cores are made is sifted on a fine wire netting, — a process which gives rise to considerable fine dust. This process, however, is not carried on to any extent, but is done, for the most part, several times a week for a few hours at a time. In one foundry the dust generated was decidedly objectionable, and upon the suggestion of the State Inspector of Health a covered sifter was provided to remove this source of annoyance.

The various processes used in the cleaning of castings are all dust producing. Castings are cleaned in tumbling mills, by sand blasts, emery wheels, or by hand with wire brushes. The tumbling mills are barrel-like chambers in which the castings are placed together with small pieces of scrap iron. After the doors are closed power is applied and the mills are set in a rotary motion. From the constant action of the castings upon each other and upon the scrap iron the surfaces are smoothed and the castings are cleaned of any sand which may be adherent. The dust generated by this process was, in most foundries, removed by exhausts. Moreover, these mills were usually located in some corner away from the workmen who did not have to attend them during operation. The emery wheels on which the castings were cleaned were in many cases provided with hoods and exhausts. In foundries where dust-removal devices did not exist the State Inspectors of Health issued orders for their installation as is indicated below.

A serious exposure to fine dry sand was observed in those foundries where sand blasts were in use for cleaning the castings. This process, which is usually carried on in a room separated from the rest of the foundry, consists of playing a stream of fine dry sand, by means of compressed air, upon the castings. So great is the force of the sand stream that the steel nozzle which is used is quickly cut through. In some foundries exhaust fans and hoods were provided to carry off the dust, although in spite of this precaution the rooms were so filled with dust while the sand blasts were in operation that objects could not be clearly seen. When doing this work the workmen usually wore masks to protect the eyes. These masks, however, did not prevent the inhalation of dust, which appeared to enter the respiratory passages with a good deal of force. In one factory, a man was observed to wear a helmet with a tubing through which fresh air was supplied from the outside. In another foundry such a helmet was provided but the man did not use it "as it was too much bother to put it on and take it off." The length of time a man can keep at this work is said to be short; in about a year or a year and a half he begins to show the effects of the work and is forced to leave.

In the Fall River District the State Inspector of Health made physical examinations of 320 molders, with the following results: —

Suffering from disease of the lungs, *e.g.*, bronchitis, asthma, emphysema, 41, or 12.8 per cent.

Suffering from disease of the heart, *e.g.*, valvular disease or dilation, 39, or 12.2 per cent.

Suffering from diseases of the kidneys, 23, or 7.2 per cent.

The total number of workers in ill health was 103, or 32.2 per cent. Their ages ranged from forty-five to seventy-two years.

Metallic Poisoning. — Besides the zinc poisoning above referred to among brass and composition workers, one case of chronic lead poisoning was found in a foundry where old lead was being refined. The man stated that he had been at this work for six years; he suffered frequently from severe colics and from obstinate constipation. A lead line at the junction of the gums and teeth could be observed.

In another foundry where white metal was being cast one man suffered from chronic antimony poisoning.

Other Influences. — Another influence prejudicial to the health of foundry workers was observed in some of the core rooms. In spraying the binder upon the outside of the core men use blow pipes. While each man is supplied with an individual pipe, these are frequently interchanged, and a man may put in his mouth a pipe previously used by some one else without cleaning it.

Cleanliness. — Cleanliness in foundries is rather difficult to define.

From the nature of the work cleanliness resolves itself to a question of orderliness, and, above all, as to whether or not the building is properly constructed, with suitable floors, either of concrete, brick or other material, which can be kept clean. In all foundries where the cleanliness was found poor the reason was due in large measure to the unfit and dilapidated condition of the building. In many of the buildings there was no covering on the earthen floor. Combined with the usually prevailing disorder, this condition tended to give an impression of untidiness and dismalness. Little improvement can be hoped for in these old and dilapidated buildings. In a considerable number of foundries conditions as to cleanliness were excellent, considering the nature of the work. These foundries as a rule were connected with manufacturing establishments, and were located in modern buildings. The condition as to cleanliness in the 209 foundries visited was recorded "good" in 158, "fair" in 26 and "poor" in 25.

Light. — While, as a rule, very few foundries appeared to be as well lighted as the best lighted factories, yet, considering the processes that were carried on, the light in many was fairly good. In a considerable number of the foundries the windows were dirty, covered with soot and dust, and, although there was sufficient light for the processes carried on, the workrooms seemed cheerless and dismal. In the largest number of the foundries the light came from the side windows and from the windows in the monitor roofs; in 28 establishments it came from the side only and consequently was poor.

Ventilation. — Ventilation in foundries is generally obtained through the windows. During the casting in those foundries in which ventilation was found fairly adequate the side windows as well as the windows in the monitor roofs and skylights were opened for the gases to escape. Most of the foundries were quite high, and the gases set free during the casting quickly rose to the top, so that the level at which the employees breathed became free from gases in a fairly short time. In the 23 foundries in the State where ventilation was observed to be inadequate, it was noted that the employees did not open the windows or skylights when the casting was carried on. In only 2 establishments in the State was artificial ventilation provided by means of exhaust fans. Ventilation during casting was found good in 128, fair in 58 and poor in 23 establishments.

Washing Facilities and Water-closets. — Men working in foundries are exposed to a great deal of unavoidable dust. The molders and core makers make the molds and cores with sand, and their hands, faces and clothing become soiled. To maintain a reasonable degree of personal cleanliness compatible with health and decency it is necessary that the men be provided with facilities for washing and a room in which they may change their clothing, as is required by section 102, chapter 514, Acts of 1909.

In the 209 foundries inspected in the State, 46 employed less than 10 men and therefore did not come within the provisions of the above section. In the 161 employing 10 or more men, 22 were exempt from the requirement of maintaining a toilet room and a water-closet because such a requirement was impracticable on account of the absence of either a public or private sewerage system.

Toilets with washing facilities and water-closets with running water were provided in 116 and lacking in 23 foundries. In 14 of the foundries where provisions were made violations of the law were observed either because the toilets were not of sufficient size or the washing facilities were not adequate. In some foundries there was a semblance of complying with the law but the provisions were entirely unsuitable and there was no evidence of their ever being used.

In this connection attention should be called to an objectionable arrangement for washing observed in several foundries, namely, that of providing a trough which is filled up before the hour of leaving work for the use of the workmen in common. In many instances these troughs were so dirty that they were unsuitable for use.

Water-closet arrangements were, as a rule, satisfactory, even in buildings where improper washing facilities were provided.

The law requiring that the water-closet shall be separate from the wash room is one that may cause unnecessary hardship. In many establishments the water-closets communicate directly with the wash rooms. If the closets are kept clean there can be no objection to such an arrangement.

The Use of Washing Facilities by Employees. — The observations made by the State Inspectors of Health in their respective districts relative to the frequency with which employees use washing facilities provided for them varied. While some of the State Inspectors of Health found that the men washed pretty generally before dinner and before leaving work, others observed small use made of the facilities provided, and men were seen to leave off work at the noon hour and proceed to eat their luncheon with soiled hands, when the sinks with running hot water were not more than 15 feet distant. In some foundries sinks and basins were in evidence in a broken and unsuitable condition; in others, where excellent washing facilities were provided, men were seen using buckets to wash in. In the best establishments many men preferred to hang their coats in the foundry near their benches rather than use the toilet room which was provided.

A great deal of education is still necessary among both employers and employees. The former should realize that the provision of good sanitary conditions is an asset, and increases the efficiency of the worker. He must, therefore, comply with the spirit as well as with the letter of the law and see that the men use properly the facilities provided for them. This is a condition that prevails in the best establishment.

The workman, on the other hand, not only should recognize the dangers to health to which he is exposed at his work, but must learn to utilize to the fullest extent the facilities which the law requires for his protection.

Numerical Data.

Number of foundries visited,	209
Foundries employing 10 or more,	163
Foundries employing less than 10,	46
Complying with section 102, chapter 514, Acts of 1909,	93
Violation of above section,	47
Foundries with no sewer connection,	23

	Orders issued	Orders complied with
Cleanliness,	8	4
Light,	1	1
Ventilation,	7	5
Removal of dust,	37	27
Proper toilet facilities,	49	34
Water-closets,	3	2
Drinking water,	1	1
	106	74[1]

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[1] Of the 32 orders not complied with some are in process of compliance while others are being followed up by the State Inspectors of Health for enforcement.

OCCUPATIONAL DISEASES. LEAD POISONING.

Investigations were carried on by several of the State Inspectors of Health to determine the effects upon the health of the operatives of various industrial processes in a variety of occupations, and to study the means whereby the workers might be protected against influences injurious to health. Special attention was given to industries in which the workers were exposed to metallic poisoning, particularly lead poisoning. As the investigations are still in progress, a complete report cannot be made at the present time. Owing to the importance of protecting persons employed in occupations involving exposure to lead poisoning, however, the following report on conditions surrounding lead workers in some industries is herewith presented: —

I. PROCESSES IN WHICH EMPLOYEES ARE EXPOSED TO LEAD POISONING.

The industries investigated were printing and the allied trades, such as stereotyping, electrotyping and type founding, the melting of lead, paint manufacturing, potteries, manufacturing of tiles, some processes in the rubber industry, and the manufacturing of insulated wire cables.

1. *Printing and Allied Trades.*

The processes in which employees are exposed to lead in the abovementioned trades are typesetting, linotyping and monotyping, stereotyping, type founding, the melting of old lead type, and the trimming and mounting of the plates on lead backs in electrotyping establishments.

In every establishment visited the superintendent, foreman and a great many employees were questioned, and in a number of instances examinations were made to discover the existence of lead poisoning. While it is difficult to draw conclusions from testimony thus obtained, it is nevertheless safe to state that lead poisoning among printers, although it occurs, is rare. Many of those interviewed have been in this trade for thirty years or over, and have come in contact with hundreds of compositors, but have never known of a case of lead poisoning. Such testimony is of course not conclusive. Lead poisoning in the above industries, when it does occur, is of the chronic type, and it is quite possible that a man beginning to show the effects of lead will quit work without the employees knowing the cause. Moreover, mild cases, giving rise to such symptoms as colic, constipation, etc., may go unrecognized.

On the other hand, in many instances histories of lead poisoning occurring among employees in these trades were obtained, but no case thus reported could be traced. In several instances employees gave histories of attacks which were undoubtedly due to lead; these will be referred to later.

a. Typesetting. — Type metal is an alloy containing from 70 to 80 per cent. of lead, with admixtures of antimony, zinc, copper, etc. Typesetters are exposed to lead from the continuous handling of the type and from the metallic dust deposited in the cases from the constant wear of the type. The typesetter may absorb the lead through the skin, or inhale the lead dust, or swallow it with his food. The danger of absorption through the skin is very small, more particularly as the fingers of typesetters — the index finger and thumb — with which the type is handled become quite calloused, rendering absorption from the calloused surface improbable.

There are, on the other hand, great quantities of dust in the type cases, which are seldom, if ever, cleaned out. Beside the lead dust from the wear of the type there is considerable plumbago, used in the process of electrotyping, which is not thoroughly cleaned off before the type is redistributed. Aside from the danger of lead intoxication, the frequency of tuberculosis among printers, as shown by the figures of the United States Census of 1900, is probably due in a large measure to the inhalation of this plumbago dust.

But more serious even than the inhalation of dust from the standpoint of lead poisoning is the swallowing of the lead dust. In many instances typesetters were observed eating fruit while at work, and handling the fruit with dust-covered hands. Frequently typesetters were observed holding type in the mouth. In several establishments, which were visited at the noon hour, men were seen to proceed to eat their luncheon at their benches, without washing their hands. In many printing establishments women are employed as typesetters; their standard of personal cleanliness is far higher than that of the men. In the establishments referred to above all the women typesetters were observed to wash their hands before eating their luncheon.

b. Monotyping and Linotyping. — Most of the composition, particularly in the larger printing offices, is now done by machines. In the linotype machine the compositor operates a keyboard similar to that of a typewriter. When he presses a lettered key a small brass matrix, with a corresponding letter, falls out from a reservoir. When a number of these matrices are assembled to form a line they are carried to a mold, where molten lead is poured on them and a complete line is cast. The matrices are then automatically redistributed to their proper places, and the lines of type, or slugs as they are called, are arranged side by side. All these processes are done automatically by the machine; the operator does not handle the lead.

In the monotype machine single letters are cast instead of lines, and these are assembled and automatically arranged into lines of required length. This machine has no keyboard but the letters are cast by a system of air pressure from a perforated roll which has been perforated first on a machine similar to a typewriter, each perforation corresponding to a given letter.

In the operation of both of these machines the danger of lead poisoning comes from the fumes of the molten lead. There is also the additional danger of vitiating the air of the room with the gases and fumes of burning oil, impurities, etc. This is particularly true in the monotype machine, in which the pot with the molten lead is exposed and the operative works directly over it. Oil from the machine continually drips on the molten metal and gives rise to disagreeable fumes. All monotype machines should therefore be hooded and connected with exhausts. Men working at these machines frequently complained of headaches; they were, as a rule, pale and poorly nourished.

The conditions are not so objectionable in the linotype machines for the pot with the molten lead is away from the operative and is, as a rule, covered. Linotype machines should likewise be hooded unless they are located in well-ventilated rooms.

Cases of plumbism are said to be very rare among the operatives of these typecasting machines. In one establishment two men were working in a small room on monotype machines. Both gave histories suggestive of a mild lead toxæmia. One man stated that for the past seven years he had been suffering at irregular intervals from attacks of colic and obstinate constipation and that several physicians diagnosed his case as lead poisoning. He had no lead line, probably due to the fact that his teeth and gums were in good condition.

c. Lead Melting. — In many establishments special furnaces were used for melting the "slugs" after they had been used, and refining and remolding the lead in brick form. The modern furnaces are so arranged that all the fumes and vapors are carried off. In some places open pots for melting the lead were found, without any provision to carry off the fumes. Men engaged in this work, besides having to handle a great deal of lead are exposed to the fumes of the molten metal. One man engaged in this work has been suffering from lead poisoning for the last nine years. He has been under treatment for it off and on. With his consent he was examined and was found emaciated and anæmic; he had a severe myocarditis and marked arterio-sclerosis and he had a distinct lead line. He realized the danger to which he was exposed but stated that he could not help himself. He took no precautions of any sort while at work. His hands were soiled from handling the lead.

d. Stereotyping. — When the type has been set up in forms it is put into heavy presses heated by steam or gas and a negative impression is made upon a specially prepared heavy paper. This paper is then set into flat or cylindrical molds and molten lead is poured on it, either with a ladle or is automatically pumped in. The formed plates are then trimmed. Men in this process are exposed to the fumes of the molten lead and handle a great deal of lead. Cases of lead poisoning were said to be not uncommon in this work, and most of the men seemed to realize the danger to which they were exposed.

e. Electrotyping. — In the process of electrotyping the workmen are exposed to the fumes of molten lead and also to the handling of a great deal of lead. In addition to the dangers of lead poisoning the workmen in some of the processes are exposed to great quantities of plumbago dust, which is more or less unavoidable. The processes of electrotyping are briefly as follows: —

An impression of the set up type is made on a layer of wax; both the type and the wax, to prevent the adhesion of the surfaces, are covered with plumbago. The wax plate is then put into a closed box, and by means of compressed air plumbago is blown on it. Opening and closing of this box gives rise to clouds of the plumbago dust, and the workmen engaged in this process are completely covered with it. Iron filings are then thrown on the surface of the wax and a solution of copper sulphate poured on it. The plate is then immersed in the electrotyping solution, and after a variable length of time, according to the desired thickness, a layer of copper is deposited on it. The deposited copper plate is then removed from the wax, thoroughly cleaned and is mounted on lead by placing it in a tray face downward and pouring lead on it.

The room where this work is done is filled with plumbago dust, and the clothing, hands and faces of the operatives are covered with this dust. A number of men who have been engaged in this work for many years stated that although they "must have inhaled and swallowed pounds of this dust" they "experienced no ill effects from it." In one establishment the man engaged in mounting the plates, who had been in this work for ten years, stated that when he first started the work he was subject to frequent attacks of severe colic and obstinate constipation, which the doctors whom he consulted at the time diagnosed as lead poisoning. These attacks, however, have diminished in frequency and severity and he now rarely has one. Aside from the general pallor and rather poor state of nutrition he showed no signs of lead poisoning. The proprietor of one electrotyping establishment stated that for several years he had been suffering from a train of gastro-intestinal symptoms attributed by his physician to lead poisoning, and that he was under treatment for it at the present time. The man looked well nourished, his teeth were in excellent condition and no lead line was present. The foreman of another establishment stated that twenty years ago he suffered from lead poisoning and was sick for a long time. He suffered from colic and headaches, and his physicians told him that he had a "lead line." He stayed out from work for a time, was under treatment and completely recovered. He then went back to the same work and has since had no trouble.

A great number of the men employed in these establishments looked pale and poorly nourished. There were some, however, who although engaged in this work for many years looked healthy and robust.

2. Paint Manufacturing.

In the manufacture of paint, the mixing and grinding of colors, all the processes with the exception of the first process are wet and give rise to no dust. The first process, that of mixing the ingredients with linseed oil, is the only one which gives rise to dust. The various ingredients, such as whiting, zinc oxide and lead salts are put in large mixers containing linseed oil, where they are thoroughly mixed and then ground with the coloring materials in grinders. The quantity of lead salts used varies in different paints and in different establishments. The proportions of carbonate of lead vary from 10 per cent. to 25 per cent.

In the first process of mixing, the ingredients, including the lead salts, are taken from open barrels with scoops and thrown into a mixer, where it forms a paste with the linseed oil. There are quantities of dust on the floors and on the operatives who do this work. In no place were any precautions taken by the workers. In one establishment respirators were provided for the men who do this work, but these were not used. In another establishment a man was observed using carbonate of lead in the mixing of paint. An open box of the powder was near him, from which he took a scoopful from time to time and threw it into the mixer, where it formed a paste with the linseed oil. When all the powder was out of the box he turned it upside down and struck it over the mixer, producing a cloud of fine lead dust, which enveloped him. The man stated that he took no precautions of any sort, and that while he had been at this work for twenty years he had been sick only once — some years ago; that the doctor who attended him diagnosed the case as lead poisoning and told him to give up his work. While talking he took out a plug of tobacco from his pocket and carried it to his mouth; his hands were covered with carbonate of lead. He was pale and emaciated, and although about forty-five years of age had marked arterio-sclerosis. He stated that some time ago several inexperienced workmen started at this work but were quickly "knocked out" and had to leave.

In another establishment the proprietor stated that he avoided the effects of lead poisoning among the mixers by shifting the men, after three months at the work, to other employment.

No histories of lead poisoning could be obtained among the grinders, although their hands and arms are continually covered with liquid paints. This is rather surprising in view of the frequency of lead poisoning among painters. The latter might possibly be explained by the fact that painters are exposed to a great deal of lead dust in scraping off old paint.

In the manufacture of dry colors, workers are exposed to the dusts and fumes of the chemicals that enter into the composition of the various colors. Some of them have salts of lead in their composition; yellow, for instance, is made by the mixture of lead acetate and sodium bichromate. Lead acetate is made by melting pig lead and pouring it into cold water. This process is called "feathering." The feathered lead is then pleated with acetic acid, and lead acetate is formed. There is thus considerable exposure to the fumes of molten lead, to the dust of lead compounds, and great quantities of lead have to be handled. The men often have to be out of work on account of lead colic, and frequently ask to be changed to different work because they claim to be suffering from lead colic.

3. Potteries and Manufacturing of Tiles.

Several of the processes carried on in potteries deserve mention from the standpoint of the health of the employees. In mixing the clay there is more or less dust from the sand. In one establishment a certain amount of "grit," consisting of dry, powdered, burnt clay, was added to the clay when it was mixed. The burnt clay was ground in a mill, and this process gave rise to a great deal of unavoidable dust. The man engaged in this work stated that he experienced no ill effects from the work although he had been at it for many years. He looked well and robust.

After the ware is formed and after it is glazed it is baked in kilns where the temperature is gradually brought up to 2,800°, at which temperature it remains for about thirty hours; the kilns are then opened and the ware is allowed to cool gradually. The workers employed about the kilns are exposed at times to excessively high temperatures.

The process which is of special hygienic interest is that of glazing. After the ware has been dried, it is dipped in a glazing solution. The ingredients of this solution are flint, felspar, china clay, etc., and carbonate of lead varying from 5 per cent. to 10 per cent. These ingredients are mixed daily by one man in a room apart from the rest of the workrooms, and it takes about two hours each day. In one establishment a man was found who had done this work for fourteen years. He had taken certain precautions as, *e.g.*, cleansing his hands before eating, and had never experienced any ill effects from the work.

In one establishment where tiles were manufactured the dipping of the tiles in the glazing solution was done by women and young girls. On some tiles requiring more than one color the glaze was put on with a brush.

Five minors who were examined at this work were all found in good health; they had all, however, been at this work for several months only. Several of the older girls from whom inquiries were made stated that they had been at this work from five to seven years, and that they had experienced no ill effects in any way. The superintendent of this establishment stated that he was very strict in insisting on cleansing of the hands before meals and before going home, and that the girls were warned of the danger from the lack of personal cleanliness.

In another establishment one "dipper" was assisted by two young boys, who had not been informed of the danger to which they were exposed, nor were they instructed as to any precautions they must take. Minors do not remain at this work for a long time, but are continually shifting.

In another establishment where tiles were manufactured 22 men were examined. One was found to be under treatment for lead poisoning; 4 showed lead lines on their gums, and 3 gave history of having suffered formerly from some form of lead poisoning, although they were well when found. The operative that was under treatment for lead poisoning contracted the disease by inhaling dust from barrels formerly containing lead compounds, which he chopped up for use in the kilns.

4. *Rubber Industry.*

The rubber industry is exceedingly important from the standpoint of the health of the operatives. The workers are exposed to numerous influences injurious to health, such as the great quantities of talc dust, naphtha fumes and fumes of bisulphide of carbon. A detailed account of the rubber industry will be published later, together with other material on industrial hygiene. Reference here is made only to the exposure of the employees in certain of the processes to lead poisoning.

Various ingredients enter in the making of rubber goods such as sulphur, whiting, zinc oxide, sulphide of antimony, tar, resin and, to a greater or less extent, white lead. In one establishment 800 pounds of white lead were used daily. In the compounding room 13 men were employed weighing out the ingredients. There was a great deal of dust, and no precautions were taken by any of the men.

In the sifting room, where the ingredients are sifted before they are sent to the compounding room, a man, who had been at this work for two months, stated that he suffered from irritation of the nose and throat, due to the dust from the antimony salts. He further stated that for the first time he suffered from attacks of colic. No precautions were taken by him. It was stated that the man previously employed in this room for five months had to give up the work on account of illness.

In the process of mixing the rubber with the other ingredients considerable dust is generated, and the workers are exposed to the lead dust.

No history of any cases of lead poisoning was obtained from the foremen or managers of any of the establishments visited. Most of them were unaware that there was any danger of lead poisoning, and did not know that such cases ever occurred in the rubber industry. In view of the fact that lead poisoning in rubber factories is not uncommon, this general ignorance among employers and employees is noteworthy.

Of 162 cases treated for lead poisoning in the out-patient department of the Massachusetts General Hospital, 18, or over 11 per cent., were among rubber workers. This discrepancy between the hospital records and information obtained at the factories can be explained by the fact that the working population in rubber factories is shifting. Many workers are taken sick and drop out without any one in the factory knowing anything about them. Inasmuch as a great proportion of the rubber workers are foreigners, — Poles, Italians, etc., — the patients themselves may not understand fully the nature of the trouble for which they are treated.

5. *Insulated Wire Cables.*

Two of the ingredients of the rubber compound used in the insulation of wire are red oxide of lead and litharge. The mixing of these compounds was carried on in a portion of the building quite apart from the other employees. One man, who had been doing this work for a number of years showed signs of lead poisoning. He stated that occasionally he had to give up his work for a few months at a time.

II. GENERAL CONSIDERATIONS RELATIVE TO LEAD INDUSTRIES.

From the above considerations it can be seen how difficult a matter it is to determine the frequency of the occurrence of lead poisoning in any industry. Those who are susceptible to the disease succumb shortly after starting work, and drop out without any record being made as to the nature of the illness. Moreover, employees may suffer from mild chronic lead poisoning without any knowledge on the part of the employer as to the nature of the illness.

Many of the employers and workmen in the above industries were found absolutely ignorant of the danger involved in the exposure to lead, and, even where such knowledge existed, there was no evidence of any precautions taken. In view of these facts it would seem desirable to have regulations governing all industries where lead is used, as well as others dangerous to health. Attention should be called in these regulations to the danger to which the workers are exposed, and protective measures against lead poisoning should be indicated. Employers should be required to post the notices in conspicuous places. Such notices would be of great educational value, and would undoubtedly in time lead to precautions on the part of the workers. A notice like the following may be serviceable.

III. PROTECTIVE MEASURES AGAINST LEAD POISONING.

Workers in lead are exposed to the poisonous effects of the metal. Lead is a subtle poison and produces its harmful effects in a slow manner. The symptoms of lead poisoning are manifold and often very obscure. The most frequent early symptoms are marked pallor of the skin, headaches, severe colic and obstinate constipation.

The poison gains entrance into the system: —

1. By swallowing minute particles of lead.
2. By inhaling lead dust or the fumes of lead in a molten state, or the vapor of lead in a fused state.
3. By absorption from the skin in handling lead.

Advice to Employees.

1. General personal cleanliness is of the first importance.
2. Thoroughly clean your hands before touching food and before leaving the workroom.
3. Thoroughly rinse your mouth before eating.
4. Take good, nutritious food and plenty of milk.
5. Take a substantial breakfast; an empty stomach is more susceptible to the poisonous effects of lead.
6. Never eat at your work. Eat your luncheon outside of the workroom if possible; if not, in a part of the room away from lead. Never smoke or use tobacco in any form while at work.
7. Avoid all excesses; alcoholic beverages are especially injurious.
8. Wear overalls or a long coat at your work; also a cap or some

head covering. Whenever practicable wear gloves when lead is to be handled.

9. Persons working in white lead or other powdered compounds of lead should always wear a respirator while at work. Cause as little dust as possible.

10. Consult a physician at the first sign of ill health.

Advice to Employers.

1. Provide washing facilities, lockers, and a place for the employees to eat luncheons away from lead.
2. Provide respirators for all the workers who have to handle white lead or other powdered compounds of lead.
3. The floors of the workrooms and benches at which men work should be cleaned daily, after thoroughly moistening them.
4. These regulations should be posted in a conspicuous place in the workroom.

RECOMMENDATION.

In order that occupational diseases shall be reported, it is recommended that the present law requiring the State Board of Health to authorize and define what diseases shall be deemed to be "dangerous to the public health" be so amended as to include such occupational diseases, or definite symptoms of disease due to occupational processes or conditions, as the State Board of Health may from time to time deem necessary.

HEALTH OF MINORS IN FACTORIES.

Explanation has been given at length in each preface of the last two reports on the work of the State Inspectors of Health as to the methods of obtaining information and making a study relative to the health of minors in factories. The law provides that each State Inspector of Health "shall inform himself concerning the health of all minors employed in factories within his district, and, whenever he may deem it advisable or necessary, he shall call the ill health or physical unfitness of any minor to the attention of his or her parents or employers and of the state board of health."

During the year more than 17,000 minors were seen and questioned as to their health. Of this number nearly 2,800 were fourteen years of age; 3,700, fifteen years; 5,500, sixteen years; and 5,300, seventeen years. The total number of physical examinations made was 888: 324 because of family tubercular history, 198 because of previous personal history, 345 because of appearance, and 21 because of the intrinsic dangers in the minor's occupation. Of the 888 minors examined physically, but 303 were found to show signs or symptoms of ill health or physical unfitness. Of the 303 minors found in ill health, 162 were males and 141 females; 46 were fourteen years of age; 63, fifteen years; 108, sixteen years; and 86, seventeen years.

Early in the year each State Inspector of Health was instructed that the parents of a minor found in ill health or physically unfit for work should be notified in writing of the nature of such ill health or physical unfitness, and that a copy of any such written communication should be forwarded to the State Board of Health.

Whenever a State Inspector of Health noted that avoidable unhygienic conditions might give rise to injurious results, he issued written orders or recommendations for changes, and saw that his orders or recommendations were complied with.

Exclusion of Minors from Occupations deemed to be Injurious to Health.

The Legislature of 1910 passed an act which, it will be noted, does not involve occupations that are dangerous to life or limb, but trades, processes of manufacture, occupations or methods deemed by the State Board of Health to be sufficiently injurious to the health of minors as to justify their exclusion therefrom.

> The state board of health may from time to time upon the written application of any citizen of the commonwealth, or upon its own initiative, after such investigation as it considers necessary, determine whether or not any particular trade, process of manufacture or occupation, or any particular method of carrying on such trade, process of manufacture or occupation, is sufficiently injurious to the health of minors under eighteen years of age employed therein to justify their exclusion therefrom, and every decision so rendered shall be conclusive evidence of the facts involved therein, except so far as the same may later be revoked or modified by a subsequent decision of the board. Whoever, after being notified that the state board of health has determined that a particular trade, process of manufacture, occupation or method is injurious as above stated, employs therein a minor under eighteen years of age shall be punished by a fine of not more than two hundred dollars and not less than fifty dollars for each offense, unless prior to the time of such employment such determination shall have been revoked or modified so as not to include the employment complained of.

The above act was approved in April, 1910, and in July of the same year the State Board of Health declared the processes named in the following schedule to be injurious to the health of minors within the meaning of the law, provided that the law "shall not apply to any factory wherein such special measures are adopted as appear to the state inspector of health to be reasonably practicable and meet the necessities of the case" (approved July 7, 1910): —

I. Processes involving exposure to poisonous dusts or substances.
   1. Processes in the manufacture of white, red, orange or yellow lead.
   2. Processes in the manufacture of lead pipe, solder and plumbers' supplies.
   3. Cutting metal articles with a mixture of lead and tin, or lead alone.
   4. Processes involving exposure to lead and the dust of plumbago in electrotyping.
   5. Processes involving the handling of white lead or lead monoxide (litharge) in rubber factories.
   6. Lead paint grinding.
   7. Lead working in the manufacture of storage batteries.
   8. File cutting by hand.
   9. Typesetting, cleaning or handling type in printing offices.
   10. Glazing in pottery establishments.

II. Processes involving exposure to irritating dusts.
   1. Processes involving exposure to the dust of graphite in the manufacture of stove polish.
   2. The operation of bronzing in the lithographing business, and the consequent exposure to bronze powder.
   3. Cutlery grinding, and grinding or polishing in the manufacture of machinery, machine parts and metal supplies; and grinding, glazing or polishing on emery or buffing wheels.
   4. Cutting, boring, turning, planing, grinding, doming, facing or polishing pearl shell.
   5. Talc dusting in rubber works.
   6. Sorting, dusting, cutting or grinding rags.

III. Processes involving exposure to poisonous gases and fumes.
   1. Spreading rubber on cloth and the consequent exposure to naphtha in the manufacture of rubber goods.
   2. The use of naphtha in cement work in rooms in shoe and rubber factories which are not provided with mechanical means of ventilation where the mixture containing naphtha is allowed to remain in uncovered receptacles.
   3. Processes involving exposure to naphtha in the manufacture of japanned or patent leather.
   4. Exposure to escape of fumes or gases from lead processes.

IV. Processes involving exposure to irritating gases and fumes.
   1. Gassing in textile factories.
   2. Singeing in print works, bleaching and dyeing works.
   3. Dipping metal in acid solutions.

V. Processes involving exposure to extremes of heat and other conditions which promote susceptibility to disease.
  1. Melting or annealing glass.

This law may be made applicable to a single establishment, to a department in an establishment, or even to a single minor. From an educational point of view it has great value. It insures fair treatment to both the employer and the minor. To illustrate with an actual case: in an establishment where minors were exposed to naphtha and the possibility of naphtha intoxication, there were a large number of uncovered receptacles containing naphtha, so that the State Inspector of Health — after consultation with the office of the State Board of Health — wrote the following letter to the employer: —

> I desire to call your attention to chapter 404 of the Acts of 1910 and to the schedule of processes declared by the State Board of Health to be injurious to health. Your attention is particularly called to paragraph 2, section III., in the list of processes. In your making-up department there are a large number of uncovered receptacles containing naphtha and naphtha cement, and no special measures are adopted which appear to me to be reasonably practicable to protect the minors employed in that department from exposure to the poisonous fumes. Unless such practicable measures are adopted all minors under eighteen years of age must be excluded from that department, in accordance with chapter 404 of the Acts of 1910. Kindly inform me as to what steps you take in the matter.

The result was a letter from the employer requesting consultation with the State Inspector of Health. This request was granted; and a short time afterward the employer sent the following letter to the inspector: —

> We have ordered covers for all of the naphtha and naphtha cement receptacles in our making room, in accordance with your suggestions. These undoubtedly will be completed at an early date. We trust that this action is to your satisfaction.

Another type of order resulted in the following case: a boy, sixteen years of age, was found at work in a fairly well-ventilated room, coming in contact with considerable lead. In this case the State Inspector of Health was directed to warn the boy and his employer to take exceptional care in regard to keeping the workroom clean and the minor to keep himself — especially his hands — clean. The inspector was further instructed to make a physical examination of the minor, and to visit the establishment a month later to learn whether sufficient precautions were taken to protect the minor's health, and to make a second examination of the minor's physical condition. The inspector would, of course, explain the danger from the oxidation of lead particles left lying about on the machines and floor, and point out the danger of handling food with the hands before thorough cleansing. In other words, we recognize an educational value in the enforcement of the law in question, and try, as far as possible, to keep the minors at work without endangering their health. In some instances, as, for example, in a dusty trade, the minors excluded from those departments wherein dust was generated in the course of manufacture have been permitted to work in other departments of the same industry where they were not exposed to injurious influences of any kind.

SANITATION OF TENEMENT WORKROOMS.

A law of the Commonwealth provides that: —

> A room or apartment in a tenement or dwelling house shall not be used for the purpose of making, altering, repairing or finishing therein coats, vests, trousers or wearing apparel of any description, except by the members of the family dwelling therein; and a family which desires to make, alter, repair or finish coats, vests, trousers or wearing apparel of any description in a room or apartment in a tenement or dwelling house shall first procure a license therefor from a state inspector of health, which shall be approved by the state board of health.

The largest number of tenement workrooms is located in Suffolk County; the next largest number is in District No. 5; a smaller number in Districts Nos. 7 and 9, and comparatively few in several of the other districts. More than half the workrooms in Suffolk County are in the congested tenement districts. The work, which consists of finishing men's trousers, is done by the women of the family to increase the family income. The earnings of these women are often the only means of support of the entire family.

In the less congested districts of Suffolk County, and elsewhere in the State, the work which the women do consists mainly of crocheting on ladies' undervests. It is done in comfortable homes, where the sanitary conditions are beyond reproach, and for astonishingly low wages, apparently "for a pastime or for a little additional 'pin money.'" The only danger to the public health from this class of workrooms consists in the occurrence of communicable diseases in these homes and the exposure of the garments made or finished in them to infectious and contagious matter. In the workrooms in the congested tenement districts, on the other hand, objectionable conditions in the homes are often found, and frequent inspections are necessary to maintain standards of cleanliness compatible with public health.

Dr. Linenthal, State Inspector of Health of Suffolk County, describes his work on "The Sanitary Conditions of Tenement House Workrooms in Suffolk County, and their Important Relation to the Public-Health," as follows: —

When an application for a license is made to the State Inspector of Health the premises are inspected to determine the number of rooms occupied by the family, the number of inmates and the sanitary conditions, such as the cleanliness of the rooms, especially of the room where the work is to be done. Inquiries are made as to the condition of the health of the inmates, the existence of any contagious skin disease among the members of the family and the existence of communicable disease in the family applying for the license or in any other family in the building. If all the conditions are satisfactory a license is issued. The holder of the license is instructed that good sanitary conditions must be maintained in the home and that the license must be promptly returned to the State Inspector of Health should any contagious disease occur in the family or among any of the occupants of the building.

If the premises are found to be unclean, if there is overcrowding, if any communicable disease is detected in any member of the family, or if any evidence is found of contagious skin disease, the license is refused.

When a license is issued, a record of it containing a detailed description of the premises and of the number of inmates is filed in the office of the State Inspector of Health. This record is referred to on subsequent inspections. In addition to such records a carefully registered street index is kept, so that the number of workrooms in any street or in any building in the district can be had on reference.

The local boards of health submit to the State Inspector of Health daily reports of the occurrence of communicable diseases in their respective cities. These lists are examined daily and checked off from the street index of the tenement workrooms, so that the occurrence of communicable disease in a workroom is immediately discovered. If any such disease is reported from a family holding a license to work on wearing apparel, or from any family in the building where a license is held, the premises are visited at once, and, if necessary, the license is revoked. In case it is found that the articles on which work is done are exposed to infectious material the local board of health is notified to take such action as the public safety may require.

There are at present about 1,600 licensed tenement workrooms in the district. This number is continually changing. Many of the holders of licenses move frequently, and new licenses have to be issued for the new premises. Since my appointment as State Inspector of Health about 4,000 licenses have been issued and about 7,000 inspections made. Over 200 cases of communicable diseases have been investigated and the necessary steps taken to prevent the spread of disease from these workrooms.

A great many of the workrooms are located in the congested tenement district. The work is done in the kitchen, which is also used as a dining room and living room. In these workrooms one is apt to find conditions of overcrowding; dark, poorly ventilated halls; unclean water-closets; bedrooms with windows opening into narrow, dirty alleys, into air shafts or having no windows at all. In the evening, when all the inmates come together, these kitchen workrooms are overcrowded, and the finished garments may be taken into the bedrooms and placed upon the beds which are often unclean. To maintain sanitary conditions in these workrooms compatible with public health, frequent inspection is essential. Subsequent inspections may reveal conditions of uncleanliness and overcrowding which did not exist at the time the license was issued.

During the year special attention was given to the frequent inspection of premises in the congested districts where licenses were held, and efforts were directed to maintain higher sanitary standards in these homes. The results have been gratifying in many respects. The women — mostly Italians — who hold the licenses in the tenement districts are learning to maintain better sanitary conditions in the home. They are gradually being educated to the importance of decent sanitary standards. It is only by close personal contact and friendly visits to their homes that these people can be reached. The general educational campaigns that are being carried on by means of exhibits, lectures and distribution of literature do not reach them and cannot influence them. These methods are beyond the reach of the people who need instruction the most. The population of our tenement districts cannot be educated " en masse," while, on the other hand, personal, intimate and friendly contact with a visitor to the homes can and does accomplish a great deal. Our educational campaign against tuberculosis, to be effective, will have to include as a part of its program the work of a well-organized force of visitors to the homes of our tenement dwellers, where there is a great field for good and effective work.

The direct personal instruction was supplemented by a circular printed in Italian which was left at the home with each license. This circular, a copy of which was published in the last annual report, contains suggestions relative to the sanitation of the home. That there is a greater appreciation on the part of the workers of the purpose of inspection can be seen from the fact that licenses are now frequently returned to the State Inspector of Health in case of sickness occurring in families where licenses are held. Twelve licenses were sent back during the year from tenement workers because of sickness in the family.

Four hundred and forty-eight licenses were revoked during the year, either on account of unsanitary conditions, such as uncleanliness or overcrowding, or on account of the occurrence of a contagious disease in the house or in a member of the family holding the license. The most frequent cause for revoking licenses was the removal of the holder of the license without notifying the change of address.

Outside of Suffolk County the work of crocheting on ladies' knitted underwear comes mainly from one large manufacturing establishment. The knitting is done at the factory, and the garments delivered to the homes of the persons who do the work. Early in the work there was no system in operation to guard the health of the public from the possibility of the spread of infection in the homes of the workers. Persons ill with contagious diseases in some towns were released from quarantine when the danger of contagion still existed. The kind of disinfection which was carried out was that of fumigating only the room where the patient slept, although the patient frequently had access to all parts of the house. When a case of contagious disease was reported from a house, agents of the mill frequently took any infected garments found in the house to another house to be finished, thereby making it possible for the infection to spread. At the present time the premises where persons are ill with contagious diseases are visited by the State Inspector of Health, who allows no goods to be taken from an infected house until such action is taken as the public safety may require. In Suffolk County 75 licenses were revoked on account of contagious diseases as follows: measles, 28; scarlet fever, 27; diphtheria, 17; tuberculosis, 3. Thirty other cases were investigated, although in no case was a license revoked.

In but few instances were minors found at work. Six girls, fourteen years of age, were found helping with the sewing after school hours. Children, however, were frequently observed carrying bundles of trousers to and from the shops, although as a rule the older children were observed taking care of the younger ones while the mother did the sewing. Dr. Linenthal concludes as follows: —

From the above brief outline of the conditions, methods of inspection and licensing of tenement workrooms, it is clear that the problem is pre-eminently and exclusively one of public health. To quote the statute, —

> Every room or apartment in which garments or articles of wearing apparel are made, altered, repaired or finished shall be kept in a cleanly condition and shall be subject to the inspection and examination of the state inspectors of health *for the purpose of ascertaining whether said room or apartment or said garments or articles of wearing apparel or any parts thereof are clean and free from vermin and from infectious or contagious matter.*

Unlike workers in factories and workshops the tenement workers cannot be subjected to restrictive legislation as to hours of work, employment of minors, etc. The employment of minors, in fact, is very rare in the district; in upwards of 7,000 inspections 6 minors were observed helping with the sewing after school hours. In general, the older children take care of the younger ones while the mother does the sewing.

While the primary object of inspection of tenement workrooms is to guard the public health from the spread of contagious diseases by means of infected wearing apparel, it accomplishes a great deal more by the maintenance of high sanitary standards in these congested tenement homes. The friendly visits to these homes and close personal contact with the workers have been a great educational force in the development of higher standards of hygienic living. This fact becomes evident by comparing the conditions in the licensed flats with those that prevail in other flats of the same building, where no licenses are held. The difference in the sanitary conditions in these two classes of homes is often very striking.

To make our present law more effective, other industries carried on in the homes, such as the manufacture of paper boxes, artificial flowers, base balls, cigars and cigarettes, tooth brushes, etc., should be included in the provisions of the law regulating tenement workrooms. For there is surely danger of disseminating infection by means of these articles as well as by means of wearing apparel.

Numerical Data for all Districts.

Total number of visits to tenement workrooms,	3,623
Number of licenses granted,	2,103
Number of licenses refused,	59
Number of licenses revoked,	458

SANITATION OF STATION HOUSES.

Following is a brief statement as to the sanitary conditions of the police station houses, lock-ups and houses of detention in the Commonwealth. The examination of the buildings was made by the State Inspectors of Health in accordance with the provisions of Chapter 405 of the Acts of 1910.

General Conditions. — The conditions varied, of course, in different cities and towns, each one presenting special problems. In the larger cities the problem of overcrowding was prominent on account of the large number of arrests, particularly on Saturday nights and holidays, when two, three or even four prisoners were put in cells often large enough for one only. In the smaller towns, on the other hand, the main objection was to sanitary conditions, particularly in those places where there were no sewer connections, and buckets had to be used in the cells. In a number of the smaller towns some cells were found in cellars, with no light and ventilation, many of them damp and entirely unfit for use.

Location and Construction of Cells. — In 92 of the lock-ups the cells were located either wholly or partly below the street level. One hundred and fifty-three had the cells constructed of brick, 84 of steel or iron and 28 of wood. For the most part they had cement floors, with doors of iron bars.

Cleanliness of Cells. — As a rule the cells were kept fairly clean. In 38 places either all or a part of the cells were found dirty. In some of them conditions were very objectionable. The plaster of the walls in certain instances was cracked, permitting the breeding of vermin, of which at times there was sufficient evidence.

Bedding. — In a large number of station houses and lock-ups, because of the difficulty of keeping the bedding clean, the use of bedding was discontinued. In comparatively few places where bedding was used were the conditions such as to be unobjectionable. Often the mattresses were found dirty, stained with vomitus and excreta, and even had the attempt been made these mattresses could not have been properly cleaned or sterilized. The coverings which were observed in use were in many instances dirty, discarded "comforters" and padded quilts, showing very little effort to keep them in a cleanly condition.

Light and Ventilation. — All the cells located either partly or wholly below ground received their light and ventilation through the barred iron doors from the cell rooms, which, in the majority of instances, were in themselves poorly lighted, and inadequately ventilated by means of a window or a door at the end of the cell room. In some instances grated openings connected with a flue were found, either near the floor or near the ceiling of the cells, but these, as a rule, did not help in the ventilation of the cell, as tests with the anemometer did not disclose any circulation of the air. In 121 lock-ups the light was found poor, and in 118 the ventilation inadequate. In 75 lock-ups either all or part of the cells were found damp.

Heating. — In 116 lock-ups the cell rooms were heated by steam, and in 69 stoves were used. In 90 the method of heating was not given. With the exception of 8 places all the lock-ups were well heated.

Overcrowding. — Overcrowding was one of the most objectionable features in many of the stations in the large cities. Three and sometimes four prisoners were put in one cell, which was just large enough for one person. The air space per capita was often exceedingly small, being as low as 70 or 80 cubic feet; in several instances the minimum was 60, and in one case as low as 48 cubic feet per capita.

Disposal of Sewage. — In 137 lock-ups there were no sewer connections and buckets were used in the cells. Where there were sewer connections the water-closets were flushed from the outside at more or less irregular intervals by the officer in charge of the cell room.

Drinking Cups and Dishes used for Food. — Drinking cups furnished to the prisoners were in the great majority of instances tin cups, which were objectionable because of the difficulty of keeping them clean. In many lock-ups these were found rusty and battered. In a few lock-ups old mugs and old glasses were used. These were, as a rule, never boiled, seldom rinsed, and were usually dirty. On several occasions a tin drinking cup was noted on the floor of a cell where three or four prisoners were confined. The sides and rim of the cups were soiled with expectoration.

Food is almost universally obtained from without the station or lock-up. It is brought from the home of the keeper or janitor, or from an adjoining restaurant, and the dishes are returned afterwards to the places whence they came, there to be washed and cared for.

INSPECTION OF SLAUGHTERHOUSES.

During the year more than 132 inspections of slaughterhouses were made and 62 visits to markets.

Slaughterhouse conditions in general showed noticeable improvement as compared with conditions found the previous year, and there was evident a distinctly greater effort to prevent violations of the law.

The opinion was again expressed that, in order to secure satisfactory inspection, all slaughtering should be done in municipal slaughterhouses, under the supervision of trained officials, instead, as at present, of the common practice of slaughtering at many scattered establishments, often unfit, with inspectors who have had no training and who have no special knowledge to fit them for the work.

As illustrating some of the difficulties associated with the inspection of slaughtering, an instance was mentioned where a proprietor of a slaughterhouse was forbidden to carry on business in one town, but within three weeks the same proprietor was granted a license to slaughter in an adjoining city, and that, too, without any previous inspection of the premises to ascertain whether they were suitable, and notwithstanding the fact that the licensing board knew of the reasons why he had been forbidden to carry on business in the adjoining town.

In two instances meat not properly stamped was condemned.

In the town of Lynnfield there were two prosecutions for conducting a slaughterhouse without a license. Conviction was secured in both cases, one being fined $50 and the second case being placed on file.

Eighteen conferences were held with meat inspectors and boards of health relative to the work of inspection.

Conditions noted specifically in certain towns are as follows: —

Acushnet. — Inspection is thorough. No violations of the law known.

Athol. — The building is much improved over a year ago, but is still unsatisfactory.

Berkley. — There are no known violations of the law.

Cambridge. — At three slaughterhouses in North Cambridge conditions were found satisfactory, and inspectors were present at the time of slaughtering.

Dartmouth. — Conditions are improved, but still unsatisfactory. There is probably more or less slaughtering without inspection.

Dighton. — Inspection of slaughtering is strict and satisfactory.

Fairhaven. — Inspection is satisfactory, and no violations of the law are known.

Fall River. — All licensed slaughterers are required to do slaughtering in one slaughterhouse. Permits are issued daily, and no slaughtering is done in the absence of the inspector.

Fitchburg. — The slaughterhouse is a good building, with cement floor and walls, with good drainage, light and ventilation. There is a well-arranged refrigerator and running water.

Freetown. — There is but little slaughtering, and no violations of the law are permitted.

Lunenburg. — The walls of the slaughterhouse have been improved by the use of zinc plates 4 feet high. Drainage has been improved, and running water is about to be installed.

Marion. — No violations of the law are known.

Mattapoisett. — No violations of the law are known.

Middleborough. — A new inspector has been appointed and the inspection is efficient.

New Bedford. — All slaughtering must be done in one place. No carcasses are permitted to pass without legal inspection.

Rehoboth. — An inspector is paid $800 for the work of inspection, and devotes most of his time to the work. There is a suspicion that certain licensees from without the State evade the law, but the authorities deny this.

Rochester. — A large slaughtering business is done. The inspector is a licensed slaughterer, and a selectman is also meat inspector. There are frequent complaints that " bob " veal from this town finds its way to the markets of Fall River, New Bedford and Brockton.

Seekonk. — The inspection of slaughtering is fairly carried out, but there is reason for thinking that many carcasses are brought in from over the line (Rhode Island) without inspection.

Sterling. — The slaughterhouse has a cement floor and cement walls, with good drainage, light and ventilation. There is running water and a good refrigerator.

Somerset. — Inspection is satisfactory; violations of the law are not suspected.

Southampton. — The slaughterhouse is satisfactory.

Swansea. — Inspection is thorough and satisfactory.

Westport. — Conditions are much improved. Inspection is probably thorough, but there is much dissatisfaction with the fees charged.

SPECIAL STUDIES OR INVESTIGATIONS.

In addition to the routine work and the usual methods of procedure of the State Inspectors of Health in the enforcement of the statute provisions, opportunity was given to all of the men to become exceptionally proficient in some one or more branches of public health work. The subjects thus specifically dealt with during the present year and the names of the men who made original investigations are as follows: —

I. On certain phases of the tuberculosis problem: Doctors Coon, Simpson, Hitchcock and Jones.

II. On the tenement-house problem: Dr. Linenthal.

III. On the regulation of artificial moisture and heat in textile factories: Doctors MacKnight, Coon, Simpson and Fish.

IV. On the health of persons employed in spinning and weave rooms in textile mills: Dr. Coon.

V. On devising some practical method for the detection of injurious amounts of irritating or poisonous dust in the air of factory workrooms (actual experiments and tests made in connection with the occupational processes): Dr. Walcott.

VI. On the health of minors in factories in relation to the kind of work done and the conditions to which the minors are exposed: Doctors Washburn, Coon and Fish.

VII. On the protection of persons exposed to lead dust, fumes and vapors: Doctors Linenthal, Morse and Walcott.

VIII. On provisions for the injured in different occupations: Dr. Walcott.

IX. On the protection of workers in foundries: Doctors MacKnight and Linenthal.

X. On the hygiene of occupation (general work covering many occupations): Doctors Washburn and Walcott.

XI. On the practical use of chemical disinfectants (laboratory and field experiments): Dr. Walcott.

It should be stated that the presence of a man's name under some topics but not under others, or the absence of his name, does not necessarily indicate his lack of special familiarity with any particular subject.

While it is true that in some instances the men have traveled beyond their own health district lines, in order to get the desired information, it should be said that one health district may afford opportunities for investigation along certain lines which are nearly or entirely absent in another district.

Finally, the good spirit in which such work is conducted permits the recognition of special qualifications in different individuals, thereby making district boundaries of minor importance in the accomplishment of the desired results.

CHEMICAL DISINFECTION. — FUMIGATION EXPERIMENTS.

By Wm. W. Walcott, M.D., State Inspector of Health.

The following experiments were undertaken to test the value of chemical disinfection after disease. They were carried out as nearly under service conditions as possible; that is, the tests were made under conditions closely simulating those found after a case of disease, and in the manner in which the average disinfector does his work.

Two rooms were used in the diphtheria building of the Newton Hospital. They were alike in all respects, except that room 2, the control room, had a fireplace, whereas room 1, the test room, had none. Each contained an ordinary hospital bed, a glass and iron bed stand and a wooden chair; each had a window, a door, with a transom over it, a register and a ventilating duct. The register and ventilator were covered with paper gummed to the wall, the transom and window were sealed with ordinary adhesive paper strips, and at each test the keyhole, knob socket and cracks around the door were stuffed with absorbent cotton.

Each room contained 1,057 cubic feet. Room 1 faces W. N. W. and room 2, E. S. E.

The test cultures were taken from patients in the diphtheria and scarlet fever wards, and from suppurating wounds, and were "fresh cultures" except where otherwise noted.

The method of obtaining the cultures was as follows: swabs were taken, and blood serum tubes, inoculated from the swabs, were incubated for twenty-four hours. At the end of that time, sterile cloths inoculated from the cultures were placed at different levels in the rooms or smears placed on the walls or floor, and exposed to the disinfectant for twenty-four hours. At the end of that time the rooms were opened and blood serum tubes inoculated from the test cultures.

The inoculations were made by moistening sterile swabs in sterile water and rubbing them over the test cultures. The tubes were then incubated for twenty-four hours, at the end of which time slides were examined and the growths checked against those of the original cultures. If no growth was found at the end of twenty-four hours the incubation was continued for forty-eight hours, and, if necessary, for seventy-two hours. If no growth was found at the end of that time, the culture was considered sterile.

Formalin (40 per cent. solution) was the disinfectant used. Various methods of generating the gas were tried; viz., the Sanitary Construction Company's regenerator, the permanganate method; aluminum sulphate, chloride of calcium and certain proprietary forms of so-called "solid formaldehyde." These latter were used strictly according to the printed directions, except that double the required amount of the preparation was sometimes used.

Experiment No. 1. — Six test cultures on cloth. Cultures placed on bed, mantel and floor; 2 cultures on each level; 1 staphylococcus aureus; 1 streptococcus. Amount of formalin, ℥xv from Sanitary Construction Company's regenerator. Blood serum tubes inoculated and incubated for twenty-four hours.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
Floor: —		
Staphylococcus aureus,	Positive,	Positive.
Streptococcus,	Positive,	Positive.
Bed: —		
Staphylococcus aureus,	Positive,	Positive.
Streptococcus,	Positive,	Positive.
Mantel: —		
Staphylococcus aureus,	Positive,	Positive.
Streptococcus,	Positive,	Positive.

Experiment No. 2. — Conditions and tests same as in experiment No. 1, but only formalin ℥xiii used.

After seventy-two hours' incubation both the test cultures and controls remained sterile, there being evidently some error in technique.

Experiment No. 3. — Test cultures used: No. 1, mixed culture from diphtheria patient, containing KL and streptococci; No. 2, streptococci (second remove); No. 3, staphylococci (third remove); No. 4, culture from nose of scarlet fever patient, containing KL and streptococci; No. 5, culture from nose of scarlet fever patient, containing streptococci (no KL).

Cultures placed as follows: No. 1, smeared on the wall about 5 feet from floor; wall not sterilized. No. 1*a*, on cloth, placed on the floor. No. 2, on cloth, placed on the bed. No. 3, on cloth, placed on the chair. No. 4, on cloth, placed on bed stand. No. 5, on cloth, placed on bed stand. Controls in corresponding situations in room 2.

Disinfectant used: formalin 40 per cent., amount ℥xvi, Sanitary Construction Company's regenerator.

Inoculations made twenty-four hours later on blood serum tubes, except No. 2 and No. 3, which were made on agar.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 1*a*,	Positive,	Positive.
No. 2,	Negative,	Negative.
No. 3,	Positive,	Positive.
No. 4,	Positive,	Positive.
No. 5,	Positive,	Positive.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 1*a*,	Positive,	Positive.
No. 2,	Negative,	Negative.
No. 3,	Positive,	Positive.
No. 4,	Positive,	Positive.
No. 5,	Positive,	Positive.

Seventy-two Hour Incubation.

Same as forty-eight hour incubation.

Experiment No. 4. — Cultures used: No. 1, streptococci; No. 2, mixed culture; No. 3, staphylococcus aureus (transplant); No. 4 and No. 5, same as in experiment No. 3; No. 6 and No. 6*a*, KL.

Culture No. 1, on cloth placed on foot of bed; No. 2, on cloth, middle of bed; No. 3, on cloth, head of bed; No. 4, on pillow; No. 5, on cloth on chair; No. 6, on wall; No. 6*a*, on cloth on floor. Controls the same.

Amount of formalin, ℥xxviii, Sanitary Construction Company's regenerator.

Twenty-four hours later, inoculations were made on blood serum tubes and placed in incubator.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.
No. 3,	Negative,	Negative.
No. 4,	Negative,	Positive.
No. 5,	Positive,	Positive.
No. 6,	Negative,	Positive.
No. 6*a*,	Negative,	Positive.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.
No. 3,	Negative,	Negative.
No. 4,	Negative,	Positive.
No. 5,	Positive,	Positive.
No. 6,	Positive,	Positive.
No. 6*a*,	Negative,	Positive.

Seventy-two Hour Incubation.

Same as forty-eight hour incubation.

Experiment No. 5.—Cultures used: No. 1, streptococci; No. 2, staphylococci aurei; No. 3, same as No. 5 in experiment No. 4.

Culture No. 1, on cloth on bed; No. 2, on cloth on bed; No. 3, on pillow. Controls the same.

Amount of formalin used, ℥xviii, Sanitary Construction Company's regenerator.

Twenty-four hours later, inoculations were made on blood serum tubes.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.
No. 3,	Positive,	Positive.

Experiment No. 6.—Cultures used: No. 1, mixed culture, KL and streptococci; No. 2, staphylococci aurei and streptococci; No. 6, pure culture staphylococci aurei.

No. 1 placed on pillow; No. 2, middle of bed; No. 3, foot of bed. Controls the same.

Disinfectant used: permanganate of potash ℥x, formalin, 40 per cent., ℥xx. Experiment a failure. All tubes sterile after seventy-two hours' incubation.

Experiment No. 7.—Cultures used: No. 1, mixed culture, containing streptococci; No. 2, pure culture staphylococci aurei. Inoculated on cloths and placed on floor, bed and mantel. Controls the same.

Disinfectant used: 1½ pounds quick lime, 12 ounces formalin and aluminum sulphate, 4 ounces water.

Inoculations made at end of twenty-four hours on blood serum tubes.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1, floor,	Negative,	Negative.
No. 2, floor,	Negative,	Positive.
No. 1, bed,	Positive,	Positive.
No. 2, bed,	Positive,	Negative.
No. 1, mantel,	Negative,	Negative.
No. 2, mantel,	Positive,	Positive.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1, floor,	Positive,	Positive.
No. 2, floor,	Positive,	Positive.
No. 1, bed,	Positive,	Positive.
No. 2, bed,	Positive,	Positive.
No. 1, mantel,	Negative,	Positive.
No. 2, mantel,	Positive,	Positive.

Seventy-two Hour Incubation.

Same as forty-eight hour incubation.

Experiment No. 8. — Cultures used: same as in experiment No. 7, and placed similarly.

Disinfectant used: permanganate of potash, ℥viii, formalin, 40 per cent., ℥xvi.

Inoculations made on blood serum at the end of twenty-four hours.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1, floor,	Negative,	Positive.
No. 2, floor,	Positive.	Positive.
No. 1, bed,	Negative,	Negative.
No. 2, bed,	Positive,	Positive.
No. 1, mantel,	Positive,	Positive.
No. 2, mantel,	Positive,	Positive.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1, floor,	Negative,	Positive.
No. 2, floor,	Positive,	Positive.
No. 1, bed,	Positive,	Positive.
No. 2, bed,	Positive,	Positive.
No. 1, mantel,	Positive,	Positive.
No. 2, mantel,	Positive,	Positive.

Seventy-two Hour Incubation.

Same as forty-eight hour incubation.

Experiment No. 9. — Cultures used: same as in experiments No. 7 and No. 8, and placed at same level. These cultures were four removed from the original source.

Disinfectant used: permanganate of potash, ℥ix, formalin, 40 per cent., ℥xviii.

Inoculations made on blood serum.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1, floor,	Negative,	Positive.
No. 2, floor,	Negative,	Positive.
No. 1, bed,	Negative,	Positive.
No. 2, bed,	Negative,	Negative.
No. 1, mantel,	Negative,	Positive.
No. 2, mantel,	Negative,	Positive.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1, floor,	Negative,	Positive.
No. 2, floor,	Positive.	Positive.
No. 1, bed,	Negative,	Positive.
No. 2, bed,	Negative,	Negative.
No. 1, mantel,	Negative,	Positive.
No. 2, mantel,	Positive,	Positive.

Seventy-two Hour Incubation.

Same as forty-eight hour incubation.

Experiment No. 10. — Cultures used: No. 1, mixed culture (second remove), KL and streptococci; No. 2 and No. 3, same as in experiments Nos. 7, 8 and 9. No. 1, on pillow, No. 2 and No. 3, on floor and mantel.

Disinfectant used: permanganate of potash, ℥x, formalin, ℥xx.

Inoculations made on blood serum after twenty-four hours.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1, pillow,	Negative,	Negative.
No. 2, floor,	Negative,	Positive.
No. 3, floor,	Positive,	Positive.
No. 2, mantel,	Negative,	Positive.
No. 3, mantel,	Positive,	Positive.

Forty-eight Hour Incubation.

Same as twenty-four hours.

Seventy-two Hour Incubation.

Same as forty-eight hour incubation.

Experiment No. 11. — Cultures used: No. 1, from patient in diphtheria ward, containing KL and streptococci; No. 2, from patient in diphtheria ward, containing KL and streptococci; No. 3, KL (third remove). Cultures all placed on the bed.

Disinfectant used: disinfecting candle, said to be enough for 2,000 cubic feet.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.
No. 3,	Positive,	Positive.

Experiment No. 12. — Cultures used: No. 1, mixed culture from diphtheria patient, mainly KL; No. 2, streptococci; No. 3, staphylococci aurei.

Disinfectant used: permanganate of potash, ℥ xviii, formalin, 40 per cent., ℥ xxxii.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Negative,	Positive.
No. 2,	Positive,	Positive.
No. 3,	Positive,	Positive.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.

Experiment No. 13. — Cultures used: No. 1, from nose of scarlet fever patient, mixed culture, with streptococci predominating; No. 2, from nose of scarlet fever patient, mixed fungus and staphylococci; No. 3, from nose of scarlet fever patient, mixed, with streptococci predominating; No. 4, from diphtheria patient, mixed, with KL predominating; No. 4*a*, same. Cultures placed: No. 1, No. 2 and No. 3, on bed; No. 4, on cloth on floor; No. 4*a*, smeared on wall.

Disinfectant used: International Germ Destroyer, using solid formaldehyde, said to be sufficient for 2,000 cubic feet.

Inoculations were made on blood serum.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.
No. 3,	Positive,	Positive.
No. 4,	Negative,	Positive.
No. 4*a*,	Negative,	Positive.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 4,	Positive,	Positive.
No. 4*a*,	Positive,	Positive.

Experiment No. 14. — Each of three scarlet fever patients blew his nose into two bits of sterile gauze, and the gauze was placed at different levels in each room.

Disinfectant used was International Germ Destroyer, using solid formaldehyde, said to be sufficient for 2,000 cubic feet of air space. The cultures were mixed, with streptococci predominating.

Inoculations were made on blood serum.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.
No. 3,	Positive,	Positive.

Experiment No. 15. — Cultures used: No. 1, from nose of scarlet fever patient, mixed culture, streptococci; No. 2, from nose of scarlet fever patient, mixed culture, streptococci and few KL. Cultures placed on floor close to generator.

Disinfectant used: two Depree candles, using a form of solid formaldehyde, each candle said to be good for 1,000 cubic feet of air space.

Inoculations were made on blood serum.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Negative,	Positive.
No. 2,	Positive,	Positive.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.

Seventy-two Hour Incubation.

Same as forty-eight hour incubation.

Experiment No. 16. — Cultures used: No. 1, KL; No. 2, KL; No. 3, KL, from three different sources.

Disinfectant used: four Depree candles, same as in experiment No. 15.

Inoculations were made on blood serum.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.
No. 3,	Negative,	Positive.

Forty-eight and Seventy-two Hour Incubations.

Same as twenty-four hour incubation.

Experiment No. 17. — Two cloths, inoculated with cultures from patients in diphtheria ward, were placed on the floor within 8 inches of the generator. Culture No. 1 was mixed, but *B. diphtheria* predominated; almost pure culture. Culture No. 2, mixed streptococci and KL.

Disinfectant used: International Germ Destroyer, using a form of solid formaldehyde designed to disinfect 2,000 feet of air space.

Inoculations were made on blood serum.

The disinfector worked imperfectly, about one-third by weight of the substance being left.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.

Experiment No. 18. — Two sterile cloths were inoculated directly from a swab taken from the throat of a diphtheria patient. Two sterile cloths were inoculated with a bit of membrane which came away on the swab. A blood serum tube was also inoculated from the swab and put in incubator. One cloth (No. 1) inoculated from swab and one cloth (No. 2) inoculated with membrane put on floor in each room. In room 1 both cloths laid between the disinfectors.

Disinfectant used: two Formacone Company's fumigators, each marked "sufficient to disinfect a room containing 1,000 cubic feet of air space."

Inoculations were made on blood serum. No twenty-four hour examination was made, but both tubes showed a growth.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.

Examination of control tube, inoculated from swab, showed KL and some streptococci.

Experiment No. 19. — Two test cloths, inoculated with swab from patient in diphtheria ward, patient having positive culture (No. 1 and No. 2); No. 3 inoculated with nearly pure culture of *B. diphtheria.* Controls the same.

Tests laid on floor between two Johnson & Johnson candles, each candle said to be sufficient for 1,000 cubic feet of air space. On opening the room it was found that No. 1 and No. 2 had been burned. Inoculation was made from No. 3.

Twenty-four hour incubation showed nearly pure culture of KL.

Experiment No. 20. — A practical repetition of No. 19. Culture No. 1, nearly pure *B. diphtheria;* No. 2, mixed, streptococci and *B. diphtheria.* Tests placed on floor between the fumigators, with precautions against destruction by fire from the candles.

Disinfectant used: two Johnson & Johnson candles, as above.

Inoculations were made on agar tubes.

No twenty-four hour examination.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.

Experiment No. 21. — Cultures used: No. 1, from patient in diphtheria ward, containing KL and cocci; No. 2, streptococci.

Disinfectant used: 1 ounce of International solid formaldehyde, furnished by agent and said by him to be amply sufficient for thoroughly disinfecting 1,000 cubic feet of air space.

Inoculations were made on blood serum.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.

Experiment No. 22. — Cultures used: same as in experiment No. 21.

Disinfectant used: same as in experiment No. 21.

Inoculations were made on agar.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.

Experiment No. 23. — Cultures used: No. 1, same as No. 1 in experiments No. 21 and No. 22; No. 2, culture from suppurating wound containing streptococci, *B. pyocyaneous, B. coli communis;* No. 3, culture from nose of scarlet fever patient, containing streptococci and staphylococci; No. 4, culture containing KL and streptococci from diphtheria patient.

Disinfectant used: 2 ounces of International solid formaldehyde (as in experiments No. 21 and No. 22) sufficient to disinfect 2,000 cubic feet of air space.

Inoculations made: No. 1 and No. 3 on agar; No. 2 and No. 4 on blood serum.

No twenty-four hour examination made.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Negative,	Positive.
No. 2,	Positive,	Positive.
No. 3,	Negative,	Positive.
No. 4,	Positive,	Positive.

Seventy-two Hour Incubation.

Same as forty-eight hour incubation.

Experiment No. 24. — Cultures used: No. 1, from throat of scarlet fever patient, forty-eight hour growth; No. 2, from nose of scarlet fever patient, forty-eight hour growth; No. 3, from nose of same patient as No. 2, a transplant from culture No. 2, after twenty-four hours' incubation. Location: No. 1, on pillow; No. 2, on cloth on foot of bed; No. 3, on cloth placed on table.

Disinfectant used: formalin, ℥xxxii, potash permanganate, ℥xvi.

Inoculation was made on blood serum.

Twenty-four Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Negative,	Positive.
No. 2,	Negative,	Positive.
No. 3,	Negative,	Positive.

Forty-eight Hour Incubation.

Culture.	Room 1.	Room 2.
No. 1,	Positive,	Positive.
No. 2,	Positive,	Positive.
No. 3,	Positive,	Positive.

Examination of original cultures showed No. 1, mixed culture, chiefly streptococci; No. 2, mixed culture, fungi and streptococci.

In looking over the results of these experiments, it appears that 82 separate test cultures were examined, and that 17 of these were negative. Of these 17, there were 5 in which both test and control were negative, showing that the cultures died from some cause other than the disinfectant used. This leaves 12 instances in which the test culture was negative when the corresponding control was positive. Going still further, it appears that in 8 out of these 12 negative results the cultures were several removes from the original source, leaving only 4 times that fresh cultures in the test room showed a negative result against positive controls. In the 5 instances where both test and control were negative it appears that there were 4 where the cultures were several times removed from the original source.

As regards the amount of disinfectant used, it seems evident that amounts of formalin ranging from 12 to 32 ounces to 1,057 cubic feet of air space have no consistent effect upon organisms exposed to its influence for twenty-four hours, and that the results are as varying when the two chief methods of releasing the gas are compared. The results obtained by using the permanganate method show slightly more negative findings, but in experiment No. 9, which shows the best results, the cultures were all old. When fresh cultures were used the results were no more consistent than by the other method.

The proprietary preparations, when used in the amounts specified in the directions, for the contained air space, persistently and consistently refused to give results. In two instances, where double the advertised amounts were used, there was 50 per cent. of success, but in other instances the same failure resulted.

Before the experiments were undertaken letters were sent to every town and city in the district, as well as the following cities, to determine the methods of disinfection in use: Rochester, N. Y., Washington, D. C., Detroit, Mich., Winnepeg, Man., Hamilton, Ont., Richmond, Va., Chicago, Ill., New Haven, Conn., Milwaukee, Wis., Minneapolis, Minn., Indianapolis, Ind., and Pittsburg, Pa.

The methods used included the various proprietary candles used in the experiments, as well as 40 per cent. formaldehyde in amounts varying from 8 ounces to 16 ounces per 1,000 cubic feet, and, with the permanganate and formaldehyde method, amounts not over 16 ounces and 8 ounces, respectively.

As to apparatus, it was found that the one commonly used for generating formaldehyde gas was the generator of the Sanitary Construction Company, which consists of a reservoir drained by coils of pipes heated by a kerosene lamp which delivers the gas through a 3-foot tube ⅛-inch in diameter through the keyhole.

Much time was spent upon this generator trying to determine how much formaldehyde could be vaporized in one hour, as this was the time generally used in running this generator.

It was found under the same atmospheric conditions that the amount used in one hour varied from 2 to 8 ounces, and that under varied atmospheric conditions the results were much more unsatisfactory.

Another machine of the same type was used, but the variations were practically the same, owing, perhaps, to idiosyncracies of this type of machine.

There were noted, however, two important sources of error: —

1. If an attempt were made to force the machine by using a gas flame instead of the kerosene lamp, it was found that instead of vapor raw formaldehyde would be discharged.

2. That 40 per cent. formaldehyde, unless tightly corked and properly handled, soon became 35 per cent. or even 25 per cent.

In regard to the way fumigation was practically carried out, replies to the letters, as well as visits and conferences with local boards, brought out the following customs: —

If the above-named generator, or one of similar type, were used, the tube was placed through the keyhole and the machine run for a given time, practically always one hour, but no attempt was made to determine how much formaldehyde was vaporized.

When proprietary candles were used the directions on the box were followed. The testimonials apparently were accepted without question.

Both formaldehyde and candles were stored indefinitely and later used.

Except in the cities, rooms were rarely sealed.

Many things were fumigated that could have been boiled or scrubbed or should have been destroyed.

Fumigation was often carried out by unskilled laymen, or left in charge of some busy physician who, in turn, gave the candles to the family with directions as to how they should be used.

CONCLUSIONS.

Since the results of experiments in dealing with known quantities in a room of known size under actual service conditions lead us to doubt the value of fumigation as it is carried out to-day, it seems only fair, when we consider also how the work is done in the local communities, to conclude that fumigation as actually practiced is a waste of time and money, and, furthermore, that it gives to the public a false sense of security.

While it is true that fumigation is the indirect means of causing a sick room to be thoroughly aired, it seems that even good ventilation of a room cannot justify the general practice of "fumigating" suspected bedding and such articles of the infected as could, and should, be boiled.

The laity also has such strong faith in the efficiency of the present methods of fumigation that scrubbing and subsequent cleansing of the room and its contents are considered by them unnecessary, and so frequently not done.

It would seem best, therefore, to substitute for the present day "fumigation" such precautions as thorough airing of the room, cleansing by scrubbing, and possibly renovating, and the destruction by fire of such articles as might act as media of infection, — articles that cannot be properly cleansed, aired or exposed to sunlight.

NOTE. — The foregoing experiments were carried out with the assistance of Dr. Francis George Curtis, chairman of the Newton board of health, through whose influence Dr. William W. Walcott was enabled to have the use of two rooms in the diphtheria ward of the Newton Hospital and the use of the laboratory, as well as assistance from the nurses in obtaining the necessary material.

This report is based upon the records of the proceedings and observations of the State Inspectors of Health during the period Nov. 1, 1909, to Nov. 1, 1910, in accordance with the provisions of section 4, chapter 537 of the Acts of 1907.

STATISTICAL SUMMARIES

OF

DISEASE AND MORTALITY.

A GENERAL REVIEW OF THE VITAL STATISTICS OF THE STATE.

1910.

The number of deaths in the State in 1910 was 54,407, which was equivalent to a death-rate of 16.16 per 1,000 upon the census population of 3,366,416.

The mean death-rate of the five years 1906, 1907, 1908, 1909, and 1910 was 16.60, as compared with 16.37 for the previous five years.

The following figures are presented for the ten years ended with 1910: —

Massachusetts.

YEARS.	Population.[1]	Deaths.	Death-rates.	YEARS.	Population.[1]	Deaths.	Death-rates.
1901, . .	2,870,710	48,275	16.82	1906, . .	3,044,998	50,624	16.63
1902, . .	2,937,600	47,491	16.17	1907, . .	3,086,885	54,234	17.57
1903, . .	3,006,040	49,054	16.32	1908, . .	3,129,348	51,788	16.55
1904, . .	3,076,083	48,482	15.76	1909, . .	3,172,395	51,236	16.16
1905, . .	3,003,680	50,486	16.81	1910, . .	3,366,416 ..	54,407	16.16

[1] Population estimated for intercensal years.

INFECTIVE DISEASES.

The death-rate from the principal infective diseases in 1910 did not vary greatly from that of 1909. There was a decrease in the number of deaths from diphtheria, scarlet fever, dysentery and whooping cough; and an increase in the deaths from typhoid fever, measles, cholera infantum, consumption, pneumonia, cancer and cerebro-spinal meningitis. There were no deaths from smallpox.

The deaths and death-rates from each of the foregoing diseases in the past five years are shown in the following table: —

Deaths and Death-rates from Certain Diseases in Massachusetts, 1906–1910.

	1906.		1907.		1908.		1909.		1910.	
	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.
Smallpox,	–	–	6	.019	3	.01	1	.003	–	–
Diphtheria,	743	2.44	752	2.44	747	2.38	694	2.19	679	2.02
Scarlet fever,	135	.44	285	.92	369	1.15	259	.82	254	.75
Typhoid fever,	477	1.57	389	1.26	517	1.65	390	1.23	411	1.22
Measles,	208	.68	163	.53	331	1.06	157	.49	240	.71
Cholera infantum,	2,525	8.29	2,696	8.73	2,691	8.60	2,855	9.00	3,744	11.12
Consumption,	4,608	15.14	4,771	15.46	4,445	14.20	4,393	13.85	4,503	13.38
Dysentery,	176	.58	169	.55	225	.72	215	.68	210	.62
Whooping cough,	509	1.67	243	.79	288	.92	250	.79	183	.54
Pneumonia,	5,377	17.65	5,709	18.50	5,363	17.14	5,635	17.76	6,678	19.84
Cancer,	2,603	8.55	2,744	8.89	2,814	8.99	2,871	9.05	3,028	8.99
Cerebro-spinal meningitis,	368	1.21	434	1.41	181	.58	124	.39	153	.45

In the following table a balance is presented between the deaths from the principal infective diseases in the two years 1909 and 1910, by which it appears that the sum of the deaths from these twelve causes in 1910 was higher by 2,239 than those of 1909 from the same causes: —

Deaths from Certain Infective Diseases in 1909 and 1910.

	1909.	1910.	Increase.	Decrease.
Smallpox,	1	–	–	1
Diphtheria and croup,	694	679	–	15
Scarlet fever,	259	254	–	5
Typhoid fever,	390	411	21	–
Measles,	157	240	83	–
Cholera infantum,	2,855	3,744	889	–
Consumption,	4,393	4,503	110	–
Dysentery,	215	210	–	5
Whooping cough,	250	183	–	67
Pneumonia,	5,635	6,678	1,043	–
Cancer,	2,871	3,028	157	–
Cerebro-spinal meningitis,	124	153	29	–
Totals,	17,844	20,083	2,332	93

INFANT MORTALITY.

The rate of infant mortality during the year 1910 was somewhat higher than for the years 1909 and 1908, but lower than for the years 1907, 1906 and 1905, it being 134.2 for the year 1910, as compared with 126.8 for 1909, 133.2 for 1908, 135.7 for 1907, 144.7 for·1906 and 141.4 for 1905.

The total number of births which occurred during the year ended June 30, 1910, was 85,655, and the total deaths under one during the year ended Dec. 31, 1910, were 11,499.

For the sake of accuracy the death-rate of infants under one year old is obtained by comparing the deaths of such infants occurring in a year with the mean number of infants under one living throughout a year, and this number must "lie between the annual number of births and that number diminished by the deaths under one. It would be nearer the latter than the former number on account of the excess of deaths in the first months of life" (Dr. Farr). In the following table the births in the first line are those which occurred between July 1, 1900, and June 30, 1901, inclusive, and so on through the table, the births in the last line being those for the year ended June 30, 1910.

The deaths under one in the same table are those of the calendar years ended Dec. 31, 1901, 1902, etc. The births during these ten years were 784,204, and the deaths under one year were 107,004, which is equivalent to an infant mortality-rate of 136.4 per 1,000 births for the decade. The last half of the period shows a gain over the first half, since the infantile death-rate in the last five years was 134.7 per 1,000 births, as compared with 138.4 in the first five years.

Infant Mortality, Massachusetts, 1901–1910, Ten Years.

YEARS.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.	YEARS.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.
1901, . .	72,559	9,952	137.2	1906, . .	76,730	11,106	144.7
1902, . .	71,770	10,075	140.4	1907, . .	83,230	11,293	135.7
1903, . .	73,618	10,269	139.5	1908, . .	87,112	11,606	133.2
1904, . .	74,791	9,992	133.6	1909, . .	84,352	10,693	126.8
1905, . .	74,387	10,519	141.4	1910, . .	85,655	11,499	134.2

Total births in ten years ended June 30, 1910, 784,204.
Total deaths under one in ten years ended Dec. 31, 1910, 107,004.
Mean infantile death-rate, 136.4 per 1,000 births.

CONSUMPTION.

The total number of deaths from this cause registered in 1910 was 4,503, an increase of 110 deaths in the number of deaths occurring from this disease in 1909. The death-rate from consumption, however, was less in 1910 than that of any year of record.

The following figures present the deaths and death-rates, by ten-year periods, during the half century 1851–1900, and for the single years 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908, 1909 and 1910.

Deaths and Death-rates from Consumption in Massachusetts, 1851–1910.

PERIODS.	Deaths.	Death-rates per 10,000.	PERIODS.	Deaths.	Death-rates per 10,000.
1851–60, ...	45,252	39.9	1904, ...	4,874	15.8
1861–70, ...	45,913	34.9	1905, ...	4,702	15.7
1871–80, ...	54,039	32.7	1906, ...	4,608	15.1
1881–90, ...	58,303	29.2	1907, ...	4,771	15.5
1891–1900, ...	54,374	21.4	1908, ...	4,445	14.2
1901, ...	5,033	17.5	1909, ...	4,393	13.9
1902, ...	4,685	15.9	1910, ...	4,503	13.4
1903, ...	4,531	15.1			

TYPHOID FEVER.

The following table presents the deaths and death-rates of these cities from this cause during the year 1910: —

Deaths and Death-rates from Typhoid Fever in the Cities of Massachusetts, 1910.

CITIES.	Deaths from Typhoid Fever.	Death-rates per 10,000.	CITIES.	Deaths from Typhoid Fever.	Death-rates per 10,000.
Fitchburg, ...	11	2.9	Fall River, ...	13	1.1
Pittsfield, ...	8	2.5	Waltham, ...	3	1.1
New Bedford, ...	21	2.2	Cambridge, ...	10	1.0
Lowell, ...	23	2.1	Quincy, ...	3	.9
Taunton, ...	7	2.0	Salem, ...	4	.9
Haverhill, ...	9	2.0	Somerville, ...	7	.9
Newburyport, ...	8	2.0	Everett, ...	3	.9
North Adams, ...	4	1.8	Gloucester, ...	2	.8
Lynn, ...	15	1.7	Newton, ...	3	.8
Lawrence, ...	14	1.6	Melrose, ...	1	.6
Brockton, ...	9	1.6	Beverly, ...	1	.5
Worcester, ...	23	1.6	Northampton, ...	1	.5
Holyoke, ...	9	1.6	Chicopee, ...	1	.3
Springfield, ...	13	1.5	Malden, ...	1	.2
Marlborough, ...	2	1.4	Medford, ...	–	–
Woburn, ...	2	1.3			
Chelsea, ...	4	1.2	Total, ...	307	–
Boston, ...	77	1.1			

Death-rate for the above 33 cities, 1910, 1.3.

Following is a condensed summary from the report of 1900, from which it can be seen that a decided and continuous improvement in the death-rate from typhoid fever is taking place: —

Death-rates from Typhoid Fever per 10,000, 1871–1910, Massachusetts.

1871–75,	8.2	1901–05,	1.9
1876–80,	4.2	1906,	1.6
1881–85,	4.1	1907,	1.3
1886–90,	4.6	1908,	1.7
1891–95,	3.4	1909,	1.2
1896–1900,	2.6	1910,	1.2

For the entire State the death-rates from this cause in 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908, 1909 and 1910 were, respectively, 1.95, 1.83, 1.75, 1.75, 1.73, 1.57, 1.26, 1.65, 1.23 and 1.22 per 10,000 inhabitants.

The highest death-rates from this cause among the cities appear to have occurred in Fitchburg (2.9), Pittsfield (2.5) and New Bedford (2.2); and the lowest occurred in Malden (0.2), Chicopee (0.3) and Northampton (0.5). There were no cases of typhoid fever in Medford.

DIPHTHERIA.

The following table shows the deaths and death-rates from diphtheria by five-year periods from 1876 to 1905, and for the years 1906, 1907, 1908, 1909 and 1910: —

Deaths and Death-rates from Diphtheria per 10,000, 1876–1910, Massachusetts.

YEARS.	Deaths.	Death-rates.	YEARS.	Deaths.	Death-rates.
1876–80,	13,676	15.8	1906,	743	2.4
1881–85,	8,944	9.5	1907,	752	2.4
1886–90,	8,857	8.4	1908,	747	2.4
1891–95,	7,652	6.4	1909,	694	2.2
1896–1900,	6,331	4.7	1910,	679	2.0
1901–05,	4,259	2.9			

Further and more definite information relative to diphtheria may be found in that portion of the report which relates to the production and distribution of antitoxin.

OTHER PREVENTABLE DISEASES.

The following table presents the deaths and death-rates from measles, scarlet fever, dysentery, cholera infantum, and whooping cough for the period of forty-five years, 1866–1910: —

Deaths and Death-rates in Massachusetts per 10,000 Living from Certain Infective Diseases by Five-year Periods, 1866–1905, and for the Years 1906, 1907, 1908, 1909 and 1910.

	MEASLES.		SCARLET FEVER.		DYSENTERY.		CHOLERA INFANTUM.		WHOOPING COUGH.	
	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.
1866–70,	1,081	1.6	4,670	6.8	3,244	4.7	6,943	10.1	1,481	2.1
1871–75,	1,133	1.4	6,782	8.6	2,191	2.8	12,453	15.8	1,561	2.0
1876–80,	742	.9	3,517	4.1	2,366	2.7	9,054	10.5	1,493	1.7
1881–85,	1,007	1.1	2,504	2.7	1,601	1.7	9,894	10.5	1,213	1.3
1886–90,	1,089	1.0	1,810	1.7	1,276	1.2	10,904	10.3	1,421	1.3
1891–95,	815	.7	2,857	2.4	1,083	.9	13,426	11.2	1,445	1.2
1896–1900,	948	.7	1,358	1.0	1,434	1.1	11,865	8.9	1,465	1.1
1901–1905,	1,090	.7	1,463	1.0	970	.7	13,245	9.1	1,401	1.0
1906,	208	.7	135	.4	176	.6	2,525	8.3	509	1.7
1907,	163	.5	285	.9	169	.6	2,696	8.7	243	.8
1908,	331	1.1	369	1.2	225	.7	2,691	8.6	288	.9
1909,	157	.5	259	.8	215	.7	2,855	9.0	250	.8
1910,	240	.7	254	.8	210	.6	3,744	11.1	183	.5

The deaths from cerebro-spinal meningitis were 153, a slight increase over the number of deaths recorded in 1909, and represented a death-rate of .45 per 10,000 living. In 1909 the death-rate was .39.

There were 36 deaths from tetanus during the year, 3 from actinomycosis, 2 each from glanders and malignant pustule or charbon (anthrax) and 1 from pellagra.

RETURNS OF DISEASE AND MORTALITY.

The statistical information relating to disease and mortality which has been received by the Board during each year, either through the medium of voluntary returns or in consequence of legal requirements, has, in the recent reports of the Board, been presented under four different heads or groups. Since 1902, this series of statistics has been condensed as much as can be done consistently with a clear and intelligent method of presentation.

These summaries are defined as follows: —

I. *The Weekly Mortality Returns.* — These consist of the reports of deaths, which are made up weekly and are sent to the office of the State Board by the registration officials of cities and towns. They serve principally to show the seasonal prevalence of each of the chief infective diseases, and the mortality of children under five years old, in weekly periods. Beginning with the year 1875, this series of statistics has been annually reported (see page 475 of report for that year), and was first published as a summary in the report of 1883.

II. *The Reports of Certain Infective Diseases, — Diphtheria, Scarlet Fever, Typhoid Fever and Measles.* — These are obtained from the reports of local boards of health forwarded during 1910 to the State Board as cases arose. By comparing the numbers of reported cases with the reported deaths, the mean fatality of each disease in the places from which the reports are made is obtained with a reasonable degree of accuracy.

III. *Reports of Cities and Towns, made under the Provisions of Chapter 75, Section 52, of the Revised Laws.* — By this act each local board of health is required to report to the State Board every case of "disease dangerous to the public health" which is reported to the local board. A digest of these reports is presented in Summary No. III. This summary was first published in the report of 1893, page 639.

IV. *Annual Reports made under the Provisions of Chapter 75, Section 12, of the Revised Laws.* — The full reports of deaths occurring in each city and town having over 5,000 inhabitants comprise another series of returns, which are summarized in No. IV. The population of these cities and towns, according to the census of 1910, constituted about 89 per cent. of the total population of the State. These reports are made under the requirements of the following statute: —

> In each city and town having a population of more than five thousand inhabitants, as determined by the last census, at least one member of said board shall be a physician, and the board shall send an annual report of the deaths in such town to the state board of health. The form of such reports shall be prescribed and furnished by the state board of health. (Revised Laws, chapter 75, section 12.)

This summary was first presented in the report of 1894.

NOTE. — A supply of the postal cards, necessary for the reporting of voluntary mortality returns such as are required for the data presented in Section I. of the following summary, will be forwarded to the registration officers of any city or town who are willing to contribute the necessary information.

Postal cards are also sent to all boards of health in the State, for the purpose of aiding them to comply with the provisions of chapter 75, section 52, of the Revised Laws, relative to the reporting of diseases dangerous to the public health to the State Board immediately after reports of the same are received by the local board.

Annual blank forms are also sent to each local board of health in cities and towns having over 5,000 inhabitants, for the return of such information as is called for by the provisions of chapter 75, section 12, of the Revised Laws.

I.

THE WEEKLY MORTALITY RETURNS.

In the following summary, the voluntary reports of deaths received at the close of each week from the city registrars, town clerks and boards of health of the cities and towns are epitomized for the year ended Dec. 31, 1910. The chief value of this abstract consists in the fact that it presents a continuous history of the mortality from certain specified diseases from week to week throughout the year.

This weekly report has been published in the Boston Medical and Surgical Journal every week for a period of twenty-five years or more, and also in a publication of the Board, a weekly bulletin, since and including 1883.[1]

These returns are necessarily incomplete, since they are voluntary and consequently embrace the statistics of only a portion of the population, the reporting places being chiefly the cities and large towns.

The population of the cities and towns contributing to these returns during the year was 2,424,318, or 72 per cent. of the total population.

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[1] The bulletin was changed from a weekly to a monthly publication in January, 1906.

The following items are embraced in this summary: —

Total deaths reported for each week.
Deaths of children under five years.
Deaths from acute lung diseases.
Deaths from tuberculosis, pulmonary.
Deaths from tuberculosis other than pulmonary.
Deaths from diphtheria.
Deaths from typhoid fever.
Deaths from measles.
Deaths from cerebro-spinal meningitis.
Deaths from meningitis other than cerebro-spinal.
Deaths from whooping cough.
Deaths from scarlet fever.
Deaths from erysipelas.
Deaths from influenza.
Deaths from anterior poliomyelitis.
Deaths from tetanus.

The following table contains a summary of the statistics compiled from these weekly returns of mortality: —

Summary, Jan. 1 to Dec. 31, 1910.

		Total Deaths.	Deaths under Five Years of Age.	Acute Lung Diseases.	Tuberculosis, Pulmonary.	Tuberculosis, other than Pulmonary.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Meningitis other than Cerebro-spinal.	Whooping Cough.	Scarlet Fever.	Erysipelas.	Influenza.	Anterior Poliomyelitis.	Tetanus.
	1910.																
January	1,	911	185	150	80	7	13	10	1	3	-	1	5	1	4	-	-
	8,	853	206	177	61	8	19	3	4	5	-	2	3	1	5	-	-
	15,	771	181	147	51	9	12	4	4	4	2	3	2	2	4	-	-
	22,	893	217	177	74	12	19	3	5	-	1	5	3	4	5	-	1
	29,	807	186	162	83	12	14	-	5	2	-	3	1	3	2	-	-
February	5,	724	166	123	68	12	9	2	4	1	-	1	8	5	1	-	-
	12,	812	187	132	63	10	13	2	4	2	-	1	4	4	1	-	-
	19,	865	221	169	64	15	15	1	11	1	-	1	6	5	4	-	-
	26,	835	216	156	63	12	7	5	4	7	-	2	4	3	11	-	-
March	5,	785	196	163	68	13	5	7	5	-	1	1	6	2	5	-	-
	12,	810	223	157	61	11	11	3	5	2	-	1	14	2	8	-	1
	19,	895	236	169	72	15	8	6	9	2	-	2	6	5	9	-	-
	26,	918	247	172	80	12	15	4	5	2	1	2	2	4	5	-	-
April	2,	990	254	227	71	8	7	5	9	8	-	4	5	3	9	-	-
	9,	897	208	194	57	8	8	1	1	4	3	3	5	4	8	-	-
	16,	830	216	152	84	11	8	3	7	4	1	2	6	3	20	-	-
	23,	802	204	154	81	12	11	8	7	1	1	1	7	6	4	-	-
	30,	832	224	143	72	12	11	5	4	6	-	3	8	1	10	-	-

May	7,	785	214	100	61	11	15	8	8	7	-	2	12	4	2	1	1
	14,	739	211	105	69	15	10	3	13	2	1	2	13	8	6	-	-
	21,	740	178	107	78	10	8	3	10	1	2	2	5	3	1	-	-
	28,	729	226	101	52	16	12	3	9	2	-	1	4	7	-	-	-
June	4,	698	191	91	65	13	6	7	6	-	2	2	8	3	-	-	-
	11,	683	193	70	58	10	8	6	6	2	1	-	2	1	-	-	-
	18,	700	224	70	56	9	17	4	6	6	-	3	10	4	-	-	-
	25,	676	232	63	44	13	4	8	7	2	-	4	6	-	-	-	1
July	2,	741	288	49	61	11	9	4	4	4	1	1	6	4	-	-	-
	9,	797	337	53	57	10	5	4	5	4	2	6	4	4	-	2	-
	16,	941	408	51	59	10	12	4	6	1	-	6	4	3	-	5	1
	23,	812	351	41	57	13	9	4	2	2	1	7	2	1	-	6	-
	30,	909	382	40	58	4	2	6	4	4	1	7	1	-	-	5	-
August	6,	805	398	40	58	15	7	3	5	1	1	7	4	-	-	1	-
	13,	748	327	30	51	9	2	6	1	1	-	7	4	2	-	1	-
	20,	850	350	43	54	18	2	8	3	4	1	1	-	-	-	2	-
	27,	779	319	37	57	6	10	10	4	3	-	1	2	1	-	2	-
September	3,	711	287	40	49	6	9	10	3	4	-	6	2	3	-	2	-
	10,	738	312	51	54	12	14	15	2	5	-	4	1	2	-	-	-
	17,	716	287	50	57	18	9	11	-	2	1	4	-	-	-	1	1
	24,	784	290	63	56	12	10	11	-	1	-	3	1	-	-	4	1
October	1,	725	225	80	45	15	11	12	-	1	1	1	1	-	-	5	3
	8,	803	309	73	56	14	19	10	1	1	1	5	4	1	-	5	1
	15,	686	230	50	58	11	15	8	2	2	-	3	-	1	1	-	-

Summary, Jan. 1 to Dec. 31, 1910 — Concluded.

1910.	Total Deaths.	Deaths under Five Years of Age.	Acute Lung Diseases.	Tuberculosis, Pulmonary.	Tuberculosis, other than Pulmonary.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Meningitis, other than Cerebro-spinal.	Whooping Cough.	Scarlet Fever.	Erysipelas.	Influenza.	Anterior Poliomyelitis.	Tetanus.
October 22,	693	221	85	40	3	8	8	-	2	2	4	-	-	1	2	-
29,	695	209	87	51	10	15	4	1	1	1	3	2	-	2	2	-
November 5,	686	178	87	61	7	14	16	1	3	-	1	3	-	-	-	-
12,	750	205	116	62	15	16	9	1	4	-	4	3	1	1	2	-
19,	696	174	112	47	7	4	8	-	-	1	2	2	1	1	1	-
26,	716	187	116	54	9	8	12	1	1	-	1	1	2	-	2	-
December 3,	730	176	114	54	4	12	5	2	4	-	6	-	1	3	-	-
10,	758	180	134	62	7	12	9	1	3	1	-	4	-	4	1	-
17,	764	190	123	52	10	9	4	4	1	1	8	2	5	-	1	-
24,	832	202	59	67	11	19	6	1	2	-	4	5	3	-	1	-
31,	808	181	164	56	15	16	3	3	3	1	5	8	1	1	-	-
Totals,	41,653	12,645	5,619	3,229	578	563	324	216	140	33	161	221	124	138	54	11
Weekly average,	786	239	106	61	10.9	10.6	6.1	4.1	2.6	.6	3	4.2	2.3	2.6	1	.21
Rate per 1,000 deaths,	-	303.6	134.9	77.5	13.9	13.5	7.8	5.2	3.4	.79	3.9	5.3	3	3.3	1.3	.26
Rate per 1,000 population,	17.18	5.22	2.32	1.33	.24	.23	.13	.09	.06	.01	.07	.09	.05	.06	.02	.005

Average reporting population, ... 2,424.318

Condensed Statistics embracing the Total Deaths, Deaths under Five Years, and Deaths from Certain Causes in Reporting Cities and Towns of Massachusetts for the Year ended Dec. 31, 1910.

	Deaths.	Average Number of Deaths in Each Week.	Percentage of Total Mortality.	Death-rate per 1,000 of Reporting Population.
Total deaths,	41,653	786	100.00	17.18
Deaths under five years,	12,645	239	30.36	5.22
Deaths from acute lung diseases,	5,619	106	13.49	2.32
Deaths from tuberculosis, pulmonary,	3,229	61	7.75	1.33
Deaths from tuberculosis other than pulmonary,	578	10.9	1.39	0.24
Deaths from diphtheria,	563	10.6	1.35	0.23
Deaths from typhoid fever,	324	6.1	0.78	0.13
Deaths from measles,	216	4.1	0.52	0.09
Deaths from cerebro-spinal meningitis,	140	2.6	0.34	0.06
Deaths from meningitis other than cerebro-spinal,	33	0.6	0.08	0.01
Deaths from whooping cough,	161	3.0	0.39	0.07
Deaths from scarlet fever,	221	4.2	0.53	0.09
Deaths from erysipelas,	124	2.3	0.30	0.05
Deaths from influenza,	138	2.6	0.33	0.06
Deaths from anterior poliomyelitis,	54	1.0	0.13	0.02
Deaths from tetanus,	11	0.21	0.026	0.005

II.

FATALITY OF CERTAIN INFECTIVE DISEASES.

Since the year 1891 the following statistics relative to the fatality of certain diseases have been gathered from the published reports of local boards of health. Until the passage of the law in 1893 this was the only source from which figures could be obtained on which to base the fatality of diseases as compared with cases. When the law (chapter 302, Acts of 1893) requiring local boards of health to report all cases of contagious diseases to the State Board of Health first went into effect very few returns were made, and it was not until after public notice had been given by the State Board to every board of health throughout the State that these returns came in with any regularity. The practice by the local boards of health of reporting cases of contagious diseases is now so well established, and the returns are so complete, it is no longer deemed necessary to continue the former method of basing the fatality of certain contagious diseases on the figures obtained through the annual reports of local boards, but, instead, to make use of the more complete returns as received from day to day at this office.

The diseases embraced in this summary in 1910 are diphtheria, scarlet fever, typhoid fever and measles.

The tabular list of cities and towns is omitted in this report. The summary of the figures for 1910 is as follows: —

Reported cases of diphtheria for the State,	7,390
Registered deaths from diphtheria,	679
Fatality (per cent.),	9.2
Reported cases of scarlet fever for the State,	7,882
Registered deaths from scarlet fever,	254
Fatality (per cent.),	3.2
Reported cases of typhoid fever for the State,	3,452
Registered deaths from typhoid fever,	411
Fatality (per cent.),	11.9
Reported cases of measles for the State,	18,794
Registered deaths from measles,	240
Fatality (per cent.),	1.3

The following table presents the summary of these statistics for the twenty years 1891–1910: —

Reported Cases of Infective Diseases in Massachusetts.

Diphtheria.

[Pre-Antitoxin Period.]

	1891.	1892.	1893.	1894.	Total.
Reported cases,	2,444	3,033	2,919	4,936	13,332
Deaths,	575	891	926	1,376	3,768
Fatality (per cent.),	23.5	29.2	31.7	27.9	28.3

Diphtheria.

[Antitoxin Period.]

	1909.	1910.	Total 1895–1910.
Reported cases,	7,702	7,390	121,180
Deaths,	694	679	13,518
Fatality (per cent.),	9.0	9.2	11.2

Reported Cases of Infective Diseases in Massachusetts — Concluded.

Scarlet Fever.

	1909.	1910.	Total 1891-1910.
Reported cases,	7,216	7,882	112,288
Deaths,	259	254	5,469
Fatality (per cent.),	3.6	3.2	4.9
Typhoid Fever.			
Reported cases,	2,743	3,452	52,869
Deaths,	390	411	8,865
Fatality (per cent.),	14.2	11.9	16.8
Measles.			
Reported cases,	15,060	18,794	194,869
Deaths,	157	240	2,712
Fatality (per cent.),	1.0	1.3	1.4

In the foregoing tables the statistics relating to diphtheria have been arranged in two periods, which may properly be called the pre-antitoxin and the antitoxin periods, since antitoxin came into general use in the State about the beginning of the year 1895. For the latter period the figures for 1909 and 1910 are given and the total for the sixteen years 1895 to 1910, inclusive. The mean fatality in the former period (1891–1894) was 28.3 per cent. (ratio of deaths to cases), and in the latter period (1895–1910) it was 11.2 per cent., or less than half as large.

III.

OFFICIAL RETURNS OF NOTIFIED DISEASES DANGEROUS TO THE PUBLIC HEALTH FOR THE YEAR ENDED DEC. 31, 1910.

The figures presented in the following summary are those of the official returns of diseases "dangerous to the public health," made to the State Board of Health during the year ended Dec. 31, 1910, under the provisions of chapter 75 of the Revised Laws. In this act no disease is specified as being "dangerous to the public health" except smallpox. Hence the State Board deemed it necessary to indicate the diseases which should be included in the meaning of the term "dangerous to the public health." They are the following: actinomycosis, anterior poliomyelitis, Asiatic cholera, cerebro-spinal meningitis, diphtheria, glanders, leprosy, malignant pustule, measles, ophthalmia neonatorum, scarlet fever, smallpox, tetanus, trachoma, trichinosis, tuberculosis, typhoid fever, typhus fever, varicella, whooping cough, yellow fever.

The whole number of cases of infective diseases reported to the Board in the year ended Dec. 31, 1910, under the provisions of this act, was 50,867, which was divided chiefly as follows: —

Reported cases of smallpox,	156
Reported cases of scarlet fever,	7,882
Reported cases of diphtheria,	7,390
Reported cases of typhoid fever,	3,452
Reported cases of measles,	18,794
Reported cases of cerebro-spinal meningitis,	153
Reported cases of anterior poliomyelitis,	654
Total,	38,481

The summary for the seventeen years and four months 1893–1910 is as follows: —

	Reported Cases of —							
	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Anterior Poliomyelitis.	Totals.
1893 (four months only),	35	2,914	1,109	1,525	1,503	-	-	7,086
1894,	181	6,731	4,178	2,372	2,133	-	-	15,595
1895,	1	6,194	7,806	2,438	4,868	-	-	21,307
1896,	5	3,801	8,515	2,637	6,362	-	-	21,320
1897,	18	5,495	7,613	2,104	12,695	-	-	27,925
1898,	10	3,667	3,980	2,196	4,478	-	-	14,331
1899,	105	5,349	7,134	2,776	12,355	-	-	27,719
1900,	104	6,396	12,641	2,967	10,507	-	-	32,615
1901,	773	4,356	9,793	2,689	9,398	-	-	27,009
1902,	2,314	4,613	7,036	2,721	17,249	-	-	33,933
1903,	422	5,877	6,888	2,955	9,430	-	-	25,572
1904,	100	4,100	6,772	2,605	12,511	-	-	26,088
1905 (11 months),	44	3,594	5,059	2,794	6,107	455	-	18,053
1906 (Dec. 1, 1905–Nov. 30, 1906).	85	5,162	7,967	3,093	17,048	291	-	33,596
1907,	164	7,860	9,098	2,350	5,688	428	-	25,588
1908,	16	7,833	8,939	3,639	21,745	205	-	42,377
1909 (Dec. 1, 1908–Dec. 31, 1909).	21	8,036	8,795	2,945	15,857	143	-	35,797
1910,	156	7,882	7,390	3,452	18,794	153	654	38,481
Totals,	4,504	99,860	130,713	48,258	188,728	1,675	654	474,392

By months these diseases were reported as follows: —

Cases of Infective Diseases reported to the State Board of Health by Months for the Year ended Dec. 31, 1910.

MONTHS.	Small-pox.	Scarlet-Fever.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Anterior Poliomyelitis.
January,	101	881	816	111	1,683	23	10
February,	27	698	685	101	2,389	14	2
March,	5	733	594	150	3,095	11	2
April,	4	1,367	636	147	3,380	11	4
May,	10	1,211	611	143	3,382	12	4
June,	7	607	555	141	2,218	16	22
July,	2	344	434	209	849	8	159
August,	-	257	427	803	221	11	157
September,	-	327	544	668	82	11	129
October,	-	447	685	522	213	17	97
November,	-	477	645	306	411	8	46
December,	-	533	758	151	871	11	22
Totals,	156	7,882	7,390	3,452	18,794	153	[1] 654

[1] This figure was increased to 845 by the special investigation of anterior poliomyelitis carried on during the year.

The following table is introduced for the purpose of facilitating the comparison of the seasonal prevalence of the diseases named in the table, in different years. By means of the method employed, the errors due to the difference in the length of the months are eliminated. The figures should be read as follows: for example, the mean daily number of reported cases of diphtheria throughout the year, Jan. 1, 1910, to Dec. 31, 1910, was 20.2; of scarlet fever, 21.6; of typhoid fever, 9.5; and of measles, 51.5. During the month of January the mean daily number of reported cases of these diseases was: for diphtheria, 26.3; scarlet fever, 28.4; typhoid fever, 3.6; and for measles, 54.3 (see columns marked A). Assuming a standard of 10 as a daily mean throughout the year for each disease, the ratios for January were as follows: diphtheria, 13.0; scarlet fever, 13.1; typhoid fever, 3.7; and measles, 10.6 (see columns marked B). So that for each 10 cases of diphtheria reported as a daily mean throughout the year ended Dec. 31, 1910, there were 13.0 in January, 12.1 in February, 9.5 in March, etc.

From this table it appears that the maximum prevalence of diphtheria was in January and the minimum in August. February, April, October, November and December were also above the mean in intensity of prevalence.

The prevalence of scarlet fever was above the mean in January, February, March, April and May, and below it in the remaining months. The maximum occurred in April and the minimum in September.

Typhoid fever was below the mean in the intensity of its prevalence in the months of January, February, March, April, May, June, July and December, the maximum occurring in August.

The prevalence of measles was above the mean in the months January to June, inclusive, and below it in the remaining months, the maximum occurring in April and the minimum in September.

Certain Infective Diseases. — Seasonal Intensity of Prevalence.

MONTHS.	DIPHTHERIA.			SCARLET FEVER.			TYPHOID FEVER.			MEASLES.		
	1910.		1909.	1910.		1909.	1910.		1909.	1910.		1909.
	A	B	B	A	B	B	A	B	B	A	B	B
	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.
January,	26.3	13.0	14.1	28.4	13.1	15.7	3.6	3.7	7.2	54.3	10.6	8.5
February,	24.5	12.1	10.0	24.9	11.5	12.3	3.6	3.7	3.3	85.3	16.6	15.1
March,	19.2	9.5	10.1	23.6	10.9	12.9	4.8	5.1	3.7	99.8	19.4	17.3
April,	21.2	10.5	8.2	45.6	21.1	11.3	4.9	5.2	3.7	112.7	21.9	17.6
May,	19.7	9.8	7.9	39.1	18.1	10.4	4.6	4.8	5.1	109.1	21.2	16.3
June,	18.5	9.2	8.1	20.2	9.4	9.3	4.7	4.9	6.5	73.9	14.3	17.7
July,	14.0	6.9	6.4	11.1	5.1	5.7	6.7	7.1	6.8	27.4	5.3	8.5
August,	13.8	6.8	5.9	8.3	3.8	5.0	25.9	27.3	12.5	7.1	1.4	1.7
September,	18.1	9.0	8.2	10.9	5.0	7.2	22.3	23.5	24.1	2.7	0.5	0.9
October,	22.1	10.9	13.1	14.4	6.7	9.5	16.8	17.7	24.9	6.9	1.3	2.9
November,	21.5	10.6	14.6	15.9	7.4	9.9	10.2	10.7	13.5	13.7	2.7	5.8
December,	24.5	12.1	13.4	17.2	8.0	10.9	4.9	5.2	8.4	28.1	5.5	8.0
Mean,	20.2	10.0	10.0	21.6	10.0	10.0	9.5	10.0	10.0	51.5	10.0	10.0

Cases of Infective Diseases reported to the State Board of Health from 314 Cities and Towns for the Year ended Dec. 31, 1910.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Abington, ...	3	5	10	2	1	-	-	-	-	2
Acton, ...	1	51	4	-	1	-	-	-	-	-
Acushnet, ...	2	28	1	1	-	-	-	-	1	-
Adams, ...	27	18	18	10	13	-	-	6	1	-
Agawam, ...	5	-	1	2	-	-	-	-	-	5
Alford, ...	-	1	-	-	-	-	-	-	-	-
Amesbury, ...	23	17	7	14	3	-	-	-	-	11
Amherst, ...	2	-	1	3	-	-	-	-	-	1
Andover, ...	7	32	8	1	4	-	-	-	-	-
Arlington, ...	17	37	40	1	9	-	-	-	2	2
Ashburnham, . . .	8	21	1	-	2	-	-	-	-	-
Ashby, ...	-	-	-	1	-	-	-	-	-	-
Ashland, ...	-	-	-	1	1	-	-	-	-	1
Athol, ...	29	9	28	2	6	-	-	-	6	-
Attleborough, . . .	8	188	20	22	30	-	-	1	6	3
Auburn, ...	1	9	2	2	-	-	-	-	-	-
Avon, ...	-	1	7	1	2	-	-	3	36	-
Ayer, ...	11	2	2	-	-	-	-	-	1	-
Barnstable, . . .	6	3	10	2	1	-	-	6	4	1
Barre, ...	-	15	3	-	-	-	-	-	-	1
Becket, ...	-	6	7	2	-	-	-	-	1	-
Bedford, ...	2	2	-	-	1	-	-	-	3	1
Belchertown, . . .	2	22	2	-	-	-	-	-	-	-
Bellingham, . . .	3	6	-	-	-	-	-	-	-	-
Belmont, ...	-	1	24	-	-	-	-	-	-	2
Berkley, ...	2	3	-	-	2	-	-	-	-	1
Berlin, ...	2	-	-	-	-	-	-	-	-	-
Beverly, ...	21	3	16	10	6	-	-	25	19	1
Billerica, ...	3	38	7	3	2	-	-	-	-	-
Blackstone, . . .	16	-	3	2	-	-	-	-	-	1
Blandford, ...	-	-	-	1	-	-	-	-	-	2
Bolton, ...	-	-	-	1	-	-	-	-	-	-
Boston, ...	2,524	4,196	2,162	650	3,542	70	17	434	747	44

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Bourne, ...	2	4	-	-	2	-	-	3	-	-
Boylston, ...	-	-	2	1	-	-	-	-	-	1
Braintree, ...	4	5	19	4	10	-	-	5	-	-
Brewster, ...	-	-	2	-	-	-	-	-	-	-
Bridgewater, ...	2	3	9	13	32	-	-	-	11	4
Brimfield, ...	-	43	-	1	-	-	-	-	-	-
Brockton, ...	34	179	136	102	222	5	4	14	118	7
Brookfield, ...	-	-	2	1	-	-	-	-	-	1
Brookline, ...	32	165	73	18	25	-	-	2	3	1
Burlington, ...	1	-	-	-	2	-	-	-	-	-
Cambridge, ...	314	289	344	74	292	5	-	19	91	5
Canton, ...	12	1	5	-	2	-	-	-	-	-
Carlisle, ...	2	-	-	-	-	-	-	-	-	-
Carver, ...	1	-	-	-	-	-	-	-	-	-
Charlemont, ...	1	1	6	-	-	-	-	-	-	1
Charlton, ...	4	-	25	5	-	-	-	-	-	-
Chatham, ...	-	2	-	-	-	-	-	2	-	-
Chelmsford, ...	13	144	27	9	-	-	-	2	9	-
Chelsea, ...	53	115	165	28	71	-	1	10	43	2
Cheshire, ...	-	-	4	1	-	-	-	-	-	-
Chester, ...	2	1	1	2	-	-	-	-	-	-
Chesterfield, ...	-	-	5	2	2	-	-	-	2	1
Chicopee, ...	29	146	25	28	39	-	-	25	12	9
Chilmark, ...	-	-	-	-	1	-	-	1	-	-
Clarksburg, ...	-	-	3	-	-	-	-	-	-	-
Clinton, ...	33	11	8	4	7	-	-	-	-	-
Cohasset, ...	-	-	1	-	-	-	-	-	-	1
Colrain, ...	-	7	5	1	-	-	-	-	2	-
Concord, ...	2	9	11	2	9	-	-	-	1	-
Conway, ...	-	-	-	1	-	-	-	-	-	1
Cummington, ...	-	-	-	1	-	-	-	-	-	-
Dalton, ...	1	40	11	-	6	-	-	-	-	-
Dana, ...	-	1	1	-	-	-	-	-	-	-
Danvers, ...	24	6	13	32	9	2	-	-	3	1

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Dartmouth,	1	19	2	4	4	-	-	-	-	1
Dedham,	24	152	22	8	12	-	-	-	7	3
Deerfield,	-	1	1	1	-	-	-	-	-	3
Dennis,	3	6	-	-	1	-	-	-	-	-
Dighton,	3	7	10	5	6	1	-	-	-	1
Douglas,	6	5	7	4	4	-	-	-	-	1
Dracut,	-	18	5	1	-	-	-	-	-	-
Dudley,	5	12	1	2	-	-	-	6	-	-
Duxbury,	2	15	1	1	-	-	-	-	-	-
East Bridgewater,	-	4	-	2	49	-	-	-	1	-
East Longmeadow,	2	1	19	2	-	-	-	2	-	2
Eastham,	-	6	-	-	-	-	-	-	-	-
Easthampton,	2	-	5	2	1	-	-	-	-	3
Easton,	-	-	-	2	-	-	3	-	-	-
Edgartown,	-	-	-	1	-	-	-	-	-	-
Egremont,	-	-	2	-	-	-	-	-	-	-
Enfield,	-	21	-	-	-	-	-	-	8	-
Erving,	-	-	1	-	-	-	-	12	-	-
Essex,	-	-	2	-	-	-	-	-	-	-
Everett,	75	109	142	28	75	-	-	10	24	2
Fairhaven,	17	61	2	8	3	-	-	-	8	-
Fall River,	105	179	130	207	273	3	3	69	17	67
Falmouth,	1	5	-	-	2	-	-	-	1	-
Fitchburg,	185	134	74	111	96	-	-	2	19	11
Florida,	-	8	-	1	-	-	-	8	-	-
Foxborough,	10	5	5	3	2	-	-	-	-	-
Framingham,	15	81	21	20	13	2	-	-	7	2
Franklin,	6	4	16	3	3	-	-	-	-	-
Freetown,	-	5	1	1	-	-	-	-	1	-
Gardner,	16	78	40	12	37	-	-	1	7	1
Georgetown,	-	51	-	2	-	-	-	-	-	-
Gloucester,	30	15	12	27	14	2	-	1	5	-
Goshen,	-	-	-	-	-	-	-	-	-	2
Grafton,	7	13	3	-	-	-	-	-	-	1

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Granby,	1	7	-	-	-	-	-	-	-	-
Great Barrington,	-	2	15	3	8	-	-	-	-	-
Greenfield,	14	4	39	2	-	-	-	-	-	1
Greenwich,	-	4	-	1	-	-	-	-	-	-
Groveland,	-	3	1	4	1	-	-	-	26	-
Hadley,	-	1	3	-	2	-	-	-	-	1
Halifax,	-	-	2	-	-	-	-	-	-	-
Hamilton,	-	-	1	-	-	-	-	-	-	-
Hampden,	-	1	1	-	-	-	-	-	-	-
Hanover,	1	-	-	-	-	-	-	-	1	-
Hanson,	2	10	-	1	-	-	-	-	-	-
Hardwick,	-	22	9	11	3	-	-	-	4	3
Harvard,	3	-	-	-	-	-	-	-	-	-
Harwich,	3	31	-	1	2	-	-	-	-	-
Hatfield,	2	7	28	-	-	-	-	2	-	-
Haverhill,	150	238	152	60	138	9	1	79	29	3
Hingham,	5	-	6	1	-	-	-	-	1	-
Holbrook,	2	6	5	1	3	1	-	-	3	-
Holden,	-	3	2	1	2	-	-	12	-	-
Holland,	-	-	-	-	-	-	-	-	-	1
Holliston,	5	7	2	1	-	-	-	-	-	-
Holyoke,	102	343	106	15	61	3	-	20	11	17
Hopedale,	-	23	2	1	-	-	-	-	-	-
Hopkinton,	-	2	5	-	1	-	-	2	-	1
Hubbardston,	-	2	1	2	1	-	-	-	-	1
Hudson,	3	2	4	1	-	-	-	-	-	-
Hull,	9	14	33	4	1	-	-	1	-	-
Huntington,	1	-	-	-	-	-	-	-	-	-
Hyde Park,	34	100	48	85	24	1	-	9	19	-
Ipswich,	6	136	4	62	6	3	-	-	-	6
Kingston,	1	1	3	-	2	-	-	-	-	1
Lakeville,	-	5	1	8	-	-	-	-	-	-
Lancaster,	-	-	2	2	11	-	-	-	-	-
Lawrence,	131	592	163	76	115	1	2	5	48	6

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Lee, ...	-	-	18	-	-	-	-	-	1	-
Leicester, ...	2	-	1	-	-	-	-	-	-	2
Lenox, ...	1	-	1	-	-	-	-	-	-	-
Leominster, . . .	60	132	19	7	18	-	-	9	42	2
Leverett, ...	-	6	1	-	-	-	-	-	-	4
Lexington, . . .	29	7	28	1	2	-	-	-	39	-
Littleton, ...	-	53	1	-	-	-	-	-	-	-
Longmeadow, . . .	-	1	-	-	-	-	-	-	3	-
Lowell, ...	166	1,178	295	187	127	7	-	19	27	8
Ludlow, ...	13	7	6	-	-	-	-	-	-	2
Lunenburg, . . .	-	1	1	-	-	-	-	-	-	1
Lynn, ...	195	714	273	115	166	1	4	31	17	7
Lynnfield, ...	-	-	1	-	-	-	-	-	-	-
Malden, ...	74	230	248	41	63	2	1	6	48	2
Manchester, . . .	-	1	5	1	-	-	-	-	9	2
Mansfield, ...	12	38	12	1	2	-	-	-	4	-
Marblehead, . . .	7	20	20	5	3	-	-	-	18	-
Marion, ...	2	9	1	-	1	-	-	8	-	-
Marlborough, . . .	8	601	23	25	10	-	-	-	3	-
Marshfield, ...	-	1	-	4	1	-	-	-	-	-
Mattapoisett, . . .	-	40	1	-	-	-	-	-	-	-
Maynard, ...	-	5	3	4	2	-	-	-	1	-
Medfield, ...	30	-	1	-	-	-	-	1	10	-
Medford, ...	42	180	65	14	16	-	-	26	15	2
Medway, ...	5	1	7	-	1	-	-	-	2	1
Melrose, ...	38	19	25	14	25	-	-	-	25	1
Mendon, ...	-	1	-	-	-	-	-	-	-	-
Merrimac, ...	7	-	4	2	-	-	-	-	-	-
Methuen, ...	8	88	21	7	7	-	-	15	2	-
Middleborough, . . .	21	3	5	-	2	-	-	-	-	3
Middlefield, . . .	-	1	1	-	-	-	-	1	-	-
Middleton, ...	3	-	-	-	-	-	-	-	-	-
Milford, ...	11	15	7	5	-	-	-	-	-	4
Millbury, ...	4	56	2	4	2	-	-	6	-	-

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Millis,	-	3	1	-	-	-	-	-	-	-
Milton,	10	45	23	1	6	-	-	6	13	-
Monroe,	1	-	-	1	-	-	-	5	-	-
Monson,	4	1	10	13	2	-	-	-	1	7
Montague,	-	-	2	-	1	-	-	-	-	-
Nahant,	3	2	2	-	-	-	-	-	-	-
Nantucket,	1	4	27	2	-	-	-	-	-	-
Natick,	1	-	13	-	-	-	-	-	-	-
Needham,	10	186	10	1	8	-	1	2	5	2
New Bedford,	99	673	242	185	218	6	2	13	42	30
New Braintree,	-	1	-	-	-	-	-	-	-	-
New Marlborough,	-	-	1	-	-	-	-	-	-	-
New Salem,	1	-	1	-	-	-	-	-	-	-
Newbury,	2	5	-	-	-	-	-	-	-	-
Newburyport,	26	711	3	16	24	1	-	-	11	-
Newton,	63	209	116	36	54	-	2	2	77	9
Norfolk,	1	-	-	-	-	-	-	-	-	-
North Adams,	13	77	38	10	38	-	-	11	3	2
North Andover,	5	122	12	8	-	-	-	3	-	-
North Attleborough,	5	15	7	8	8	-	-	-	6	6
North Brookfield,	1	3	11	1	-	-	6	-	2	-
North Reading,	5	4	-	-	-	-	-	-	-	-
Northampton,	13	119	17	8	34	-	-	22	49	13
Northborough,	6	3	6	-	1	-	-	-	-	-
Northbridge,	12	140	22	4	11	-	-	-	-	1
Northfield,	2	-	-	-	-	-	-	-	-	1
Norton,	6	11	1	-	1	-	-	-	-	2
Norwell,	3	1	1	3	-	-	-	-	1	4
Norwood,	14	52	4	2	13	1	-	21	17	-
Oakham,	-	7	-	-	-	-	-	-	-	-
Orange,	-	28	2	-	-	-	-	-	-	-
Orleans,	-	65	-	-	-	-	-	-	-	-
Oxford,	4	-	9	3	4	-	-	-	3	-
Palmer,	43	4	25	7	3	1	-	9	-	11

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Paxton, ...	1	-	-	-	-	-	-	-	-	-
Peabody, ...	8	59	15	3	7	2	4	7	1	-
Pembroke, ...	-	-	3	1	-	-	-	-	-	-
Pepperell, ...	-	-	-	1	1	-	-	-	1	-
Petersham, ...	-	-	-	1	-	-	-	3	4	-
Phillipston, ...	-	1	-	-	-	-	-	-	-	-
Pittsfield, ...	46	393	63	45	36	2	-	29	51	4
Plainville, ...	-	16	15	3	-	-	-	-	-	-
Plymouth, ...	37	2	7	2	7	1	-	-	8	5
Plympton, ...	1	-	-	-	-	-	-	-	-	1
Princeton, ...	-	-	-	1	-	-	-	-	-	-
Provincetown, ...	19	2	-	4	4	-	-	-	1	-
Quincy, ...	51	289	69	25	31	2	-	11	12	5
Randolph, ...	1	-	4	2	4	-	-	-	3	-
Reading, ...	8	14	16	1	-	-	28	-	1	-
Rehoboth, ...	-	2	8	-	-	-	-	-	-	-
Revere, ...	29	1	67	4	-	-	-	-	-	-
Richmond, ...	-	1	-	-	-	-	-	-	-	-
Rochester, ...	-	1	-	-	1	-	-	-	-	-
Rockland, ...	7	2	8	3	10	-	-	-	2	2
Rockport, ...	4	4	1	4	3	-	-	2	-	1
Rowe, ...	7	-	-	-	-	-	-	3	-	-
Rowley, ...	2	1	3	11	-	-	-	-	-	-
Royalston, ...	-	32	-	-	-	-	-	-	-	-
Russell, ...	6	-	-	8	-	-	-	-	-	1
Rutland, ...	-	1	2	1	566	-	-	-	-	1
Salem, ...	47	38	112	33	81	1	-	5	44	4
Salisbury, ...	1	23	1	-	-	-	-	-	-	-
Sandisfield, ...	1	-	-	-	-	-	-	-	-	-
Saugus, ...	19	127	28	8	5	-	-	2	2	-
Savoy, ...	-	4	-	1	1	-	-	-	-	-
Scituate, ...	2	1	1	-	1	-	-	-	-	-
Seekonk, ...	2	-	1	-	-	-	-	-	-	-
Sharon, ...	23	3	3	1	12	-	-	-	-	-

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Sheffield,	3	-	12	-	2	-	-	-	-	-
Shelburne,	-	-	2	1	-	-	-	-	-	-
Sherborn,	-	1	2	-	-	-	-	-	-	-
Shirley,	1	-	-	-	3	-	-	-	-	-
Shrewsbury,	3	-	1	1	-	-	-	-	-	-
Somerset,	6	-	3	2	-	-	-	-	-	3
Somerville,	225	226	319	57	153	2	-	4	11	4
South Hadley,	3	-	-	1	1	-	-	-	-	-
Southampton,	-	-	-	-	1	-	-	-	-	1
Southbridge,	13	42	66	26	7	-	-	1	1	15
Southwick,	-	-	-	-	-	-	-	-	-	1
Spencer,	4	4	1	3	3	-	-	-	-	-
Springfield,	330	550	156	72	122	4	-	107	54	132
Sterling,	-	9	2	4	-	-	-	-	-	-
Stockbridge,	1	-	6	1	1	-	-	-	-	-
Stoneham,	6	4	4	9	-	-	3	-	-	-
Stoughton,	15	7	11	1	14	-	-	-	5	-
Stow,	1	-	8	-	1	-	-	-	-	-
Sturbridge,	-	14	5	4	-	-	-	-	-	1
Sudbury,	-	-	1	-	-	-	-	1	1	-
Sunderland,	-	-	2	-	-	-	-	-	-	-
Sutton,	3	2	2	2	1	-	-	-	-	2
Swampscott,	4	30	20	26	2	1	-	4	16	1
Swansea,	5	15	-	2	-	1	-	-	-	-
Taunton,	34	141	52	24	38	1	-	5	3	21
Templeton,	5	6	-	2	2	-	-	-	1	-
Tewksbury,	3	7	-	1	-	-	-	-	5	-
Tisbury,	-	15	3	1	1	-	-	-	14	3
Topsfield,	-	-	2	1	-	-	-	-	-	-
Townsend,	-	101	-	1	-	-	-	-	-	1
Truro,	1	-	-	1	-	-	-	-	-	-
Tyngsborough,	1	80	2	1	-	-	-	3	17	-
Upton,	-	24	2	1	-	-	-	-	2	1
Uxbridge,	7	10	9	-	3	-	-	-	-	2

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Wakefield, ...	14	16	30	4	3	–	56	–	–	–
Walpole, ...	12	154	2	–	3	–	–	17	8	–
Waltham, ...	89	38	79	37	41	–	–	10	42	3
Ware, ...	20	131	1	1	6	–	–	4	2	5
Wareham, ...	3	4	2	–	5	–	–	9	–	–
Warren, ...	3	3	1	4	1	–	–	–	1	1
Washington, ...	–	9	–	–	–	–	–	–	–	–
Watertown, ...	14	100	35	3	13	1	–	2	1	1
Wayland, ...	–	1	2	37	–	–	1	–	–	–
Webster, ...	16	1	3	1	5	–	–	–	–	1
Wellesley, ...	8	230	15	2	8	1	–	6	5	1
Wenham, ...	–	–	9	–	1	–	–	–	2	–
West Boylston, ...	–	12	3	1	–	–	–	13	–	–
West Bridgewater, . .	–	–	–	2	1	–	–	–	–	1
West Brookfield, . . .	–	3	1	–	2	–	–	–	28	–
West Newbury, . . .	1	1	2	–	–	–	–	–	–	–
West Springfield, . . .	44	–	10	1	3	–	–	–	–	7
West Tisbury, ...	–	–	–	–	2	–	–	9	–	–
Westborough, ...	6	5	1	5	1	–	–	–	2	–
Westfield, ...	118	31	11	20	20	–	–	–	4	10
Westford, ...	3	5	4	1	2	–	–	–	–	–
Westhampton, ...	–	2	–	–	–	–	–	–	–	–
Westminster, ...	3	4	2	1	–	–	–	–	–	–
Weston, ...	1	9	–	3	5	–	–	–	2	3
Westport, ...	4	94	20	2	–	–	–	7	6	8
Westwood, ...	3	1	–	1	–	–	–	–	–	1
Weymouth, ...	20	2	5	–	2	–	–	–	–	–
Whately, ...	2	–	–	–	–	–	–	–	–	–
Whitman, ...	10	16	6	4	12	1	–	–	1	–
Wilbraham, ...	8	–	5	–	3	2	–	–	–	–
Williamsburg, ...	2	2	13	–	1	–	–	–	2	2
Williamstown, ...	1	2	6	2	1	–	–	–	1	3
Wilmington, ...	2	17	5	–	2	–	–	–	–	1
Winchendon, ...	6	424	1	1	1	1	17	12	5	–

Cases of Infective Diseases, etc. — Concluded.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Winchester,	17	20	56	4	9	-	-	25	37	1
Windsor,	-	1	-	-	-	-	-	-	-	-
Winthrop,	19	67	43	2	7	-	-	13	32	3
Woburn,	24	143	69	8	13	-	-	2	6	-
Worcester,	546	565	156	286	357	3	-	104	39	7
Worthington,	2	-	-	-	-	-	-	-	-	-
Wrentham,	-	10	13	-	-	-	-	-	-	-
Yarmouth,	-	-	-	-	-	-	-	1	-	-
Totals,	7,390	18,794	7,882	3,452	7,862	153	156	1,436	2,351	654

Actinomycosis occurred in the following places: —

Boston,	2
Northampton,	1
	3

Anthrax occurred in the following places: —

Boston,	2
Methuen,	3
	5

Erysipelas occurred in the following places: —

Beverly,	2
Brockton,	2
Chelsea,	6
Dighton,	1
Everett,	1
Lynn,	1
Peabody,	2
Salem,	4
Somerville,	5
Tisbury,	4
	28

Glanders occurred in the following places: —

Boston,	1
Chelsea,	1
Medford,	1
	3

Leprosy occurred in the following place: —

North Adams,	1

Malaria occurred in the following place: —

Boston,	14

Malignant pustule occurred in the following places: —

Lynn,	1
Salem,	1
	2

Meningitis other than cerebro-spinal occurred in the following places: —

Acton,	1
Athol,	1
Brockton,	1
Danvers,	1
Dedham,	1
Everett,	1
Fall River,	1
Gardner,	1
Haverhill,	4
Ipswich,	3
Lowell,	1
Malden,	1
Pittsfield,	1
Shirley,	1
Somerset,	1
Southbridge,	1
Southwick,	1
Springfield,	3
Swampscott,	1
Winchester,	1
Worcester,	2
	29

Mumps occurred in the following places: —

Abington,	1
Barre,	2
Boston,	85
Brockton,	1
Chelsea,	10
Concord,	2
Duxbury,	1
Everett,	36
Fall Rver,	2
Foxborough,	1
Georgetown,	6
Hyde Park,	2
Mansfield,	4
Methuen,	4
Milton,	1
Provincetown,	5
Salem,	5
Somerville,	3
Tisbury,	1
Winchendon,	1
Worcester,	1
	174

Ophthalmia neonatorum occurred in the following places: —

Adams,	1
Athol,	1
Attleborough,	1
Beverly,	1
Boston,	189
Braintree,	1
Brockton,	4
Cambridge,	10
Charlemont,	1
Chelsea,	1
Chicopee,	4
Concord,	1
Danvers,	1
Dudley,	2
Everett,	1
Fall River,	5
Falmouth,	2
Fitchburg,	3
Foxborough,	1
Framingham,	1
Gloucester,	3
Hardwick,	1

Haverhill,	9
Holyoke,	6
Hull,	1
Hyde Park,	1
Ipswich,	1
Lancaster,	1
Lawrence,	4
Leominster,	1
Lowell,	7
Lynn,	6
Malden,	3
Marlborough,	1
Methuen,	1
Middleborough,	1
New Bedford,	2
Newburyport,	3
Newton,	4
North Attleborough,	1
North Reading,	1
Northampton,	1
Norwood,	1
Palmer,	1
Pittsfield,	1
Quincy,	3
Randolph,	1
Rockland,	1
Rockport,	1
Rowley,	1
Salem,	7
Somerville,	2
Springfield,	12
Stoughton,	1
Stow,	1
Swampscott,	1
Taunton,	2
Topsfield,	1
Waltham,	9
Ware,	1
Watertown,	1
Webster,	2
Wellesley,	1
Westford,	1
Weston,	1
Winchester,	1
Worcester,	16
Wrentham.	1
	361

Rabies occurred in the following place: —

Waltham,	1

Tetanus occurred in the following places: —

Boston,	19
Brockton,	1
Chicopee,	1
Dartmouth,	1
Fairhaven,	1
Malden,	1
New Bedford,	1
Salem,	2
Springfield,	5
Townsend,	1
Waltham,	1
Westfield,	1
Worcester,	1
	36

Trachoma occurred in the following places: —

Boston,	4
Lawrence,	1
Lynn,	1
Plymouth,	1
	7

Tuberculosis other than phthisis occurred in the following places: —

Brookline,	1
Cambridge,	15
Chelsea,	2
Chicopee,	1
Dedham,	1
Fall River,	9
Fitchburg,	1
Gloucester,	1
Haverhill,	5
Hopedale,	1
Lancaster,	1
Malden,	1
Needham,	1
New Bedford,	3
Northampton,	1

Pittsfield,	7
Salem,	8
Southbridge,	1
Springfield,	4
Wellesley.	1
Westminster,	1
Worcester,	7
	73

List of Cities and Towns from which no Reports were received.

I. Cities.

None.

II. Towns having a Population of More than 5,000.

None.

III. Towns having a Population of More than 1,000 but Less than 5,000 in Each.

Buckland,
Gill,
Groton,
Hinsdale,
Lincoln,
Raynham,
Sandwich,
Southborough,
West Stockbridge. — 9.

IV. Towns having Less than 1,000 Inhabitants.

Ashfield,
Bernardston,
Boxborough,
Boxford,
Dover,
Dunstable,
Gay Head,
Gosnold,
Granville,
Hancock,
Hawley,
Heath,
Lanesborough,
Leyden,
Mashpee,
Monterey,
Montgomery,
Mount Washington,
New Ashford,
Otis,
Pelham,
Peru,
Plainfield,
Prescott,
Shutesbury,
Tolland,
Tyringham,
Wales,
Warwick,
Wellfleet,
Wendell. — 31.

A supply of postal cards for the purpose of reporting infective diseases to the State Board of Health, as required by statute, will be forwarded to any local board of health on application to the secretary of the State Board, Room 145, State House, Boston.

IV.

OFFICIAL RETURNS OF DEATHS IN CITIES AND LARGE TOWNS (REVISED LAWS, CHAPTER 75, SECTION 12).

1910.

In the following summary, the statistics of deaths required by chapter 75, section 12, of the Revised Laws, are presented. These statistics are returned to the Board from each city and town which has, "according to the latest census, more than five thousand inhabitants."

The cities and towns which have contributed these returns for the year 1910 comprise a somewhat longer list than that of 1909. This list embraces all of the 33 cities and the towns having more than 5,000 inhabitants in each.

The list for the year 1910 includes 111 cities and towns. The total population of this group of cities and towns in 1910 was 2,982,294, or about 89 per cent. of the total population of the State.

The United States census of 1910 has added 7 towns to the list of places having a population of more than 5,000 in each during the five years which have elapsed since the taking of the State census of 1905, viz., Belmont, Chelmsford, Easton, Fairhaven, Mansfield, Needham and North Andover.

Hingham and Williamstown have again made returns, although their populations fell below 5,000 in 1910. In addition, the following towns, now near the 5,000 mark, have voluntarily made returns, although not required by law so to do: Lexington, Ludlow, Monson and Walpole. The gain by the addition of new towns is 56,067.

The whole number of registered deaths in these cities and towns in 1910 was 47,846, and the death-rate, as calculated from the foregoing population, was 16.04 per 1,000 of the living population, that of the previous year having been 15.92 per 1,000, and that of 1908, 16.40 per 1,000.

The death-rate for the year 1910 was slightly higher than that of 1909, but lower than the death-rate of 1908, and considerably lower than the mean annual death-rate of the State for the fifty years ended Dec. 31, 1900, which was 19.22 per 1,000.

Sexes. — The number of deaths of males was 24,669, or 51.57 per cent. of the whole number of deaths whose sex was known; and the deaths of females were 23,167, or 48.43 per cent. There were 10 in which the sex was not stated in the returns.

Ages. — The deaths by four groups of ages were as follows: —

Ages.	Deaths, 1910.	Percentages of All Deaths.	
		1910.	1909.
Under 1 year,	10,538	22.05	21.63
1 to 20 years,	6,255	13.09	12.90
20 to 50 years,	10,762	22.52	23.39
50 and over,	20,234	42.34	42.08

Infant Mortality. — The deaths of infants under one year old were 10,538, or 22.05 per cent. of the total mortality, as compared with 21.63 per cent. in 1909. In the year 1900 the rate was 23; that of the five years 1906–10, respectively, constituted 22.06, 21.55, 22.92, 21.63 and 22.05 per cent. of the total mortality.

The deaths of children under five years old were 14,258, or 29.8 per cent. of the total mortality, as compared with 29.1 per cent. for the same age in 1909.

All of the percentages in the foregoing table were estimated upon the number of deaths of those whose ages were stated in the returns. The total number of deaths in which the age was not specified was 57; in 1909 it was 19.

Still-births. — The number of still-births was 3,140, and when compared with the total mortality (still-births included), this was 6.2 per cent. of the total deaths and still-births combined. In 1909 the percentage was 6.4.

Months and Quarters. — The number of deaths in each quarter of the year is shown in the following table: —

	Deaths, 1910.	Percentages.	
		1910.	1909.
First quarter,	12,665	26.48	26.22
Second quarter,	11,483	24.00	24.67
Third quarter,	12,345	25.81	24.79
Fourth quarter,	11,344	23.71	24.32
Total,	47,837	100.00	100.00

These percentages differ but little from the mean of several years. As in 1907, 1908 and 1909, the highest mortality was in the first quarter.

During the forty-year period (1856–95) the mortality was generally above the mean in the third quarters of the years and below it in the other three quarters.

The intensity of the seasonal death-rate is more accurately shown in the following table, the method employed being explained on page 575 in Section III. of these summaries, relating to disease notification. By this method the errors which are due to differences in the length of the months are eliminated.

MONTHS.	Deaths in Each Month.	Mean Daily Deaths per Month, 1910.	CENTESIMAL RATIO.	
			1910.	1909.
January,	4,236	136.6	104.2	101.8
February,	3,890	138.9	105.9	104.5
March,	4,539	146.4	111.6	112.4
April,	4,186	139.5	106.4	105.6
May,	3,783	122.0	93.1	99.6
June,	3,514	117.1	89.3	91.5
July,	4,358	140.3	107.0	91.9
August,	4,132	133.3	101.7	106.1
September,	3,855	128.5	98.0	96.8
October,	3,652	117.8	89.9	92.9
November,	3,585	119.5	91.2	92.4
December,	4,107	132.5	101.1	103.8
Annual mean,	-	131.1	100.0	100.0

The figures in the foregoing table indicate a departure in excess of the mean death-rate in January, February, March, April, July, August and December, while that of the remaining months was below the mean.

The mean maximum departure from the death-rate for each month for the period of twenty years 1856–75 was 32.9 per cent. in August, and the twenty-year period 1876–95 it was 20 per cent. in August, while that of August, 1910, was only 1.7 per cent., and those of March and July, the two months in which the death-rates were the highest, were, respectively, 11.6 and 7.0 per cent.

In the two years having the highest death-rates in Massachusetts in the past half-century or more (1849 and 1872) the maximum departures from the yearly means were, respectively, 83.4 per cent. in August, 1849, and 40 per cent. in August, 1872. That of January, 1890, the month in which the epidemic of influenza was at its maximum, was 43.4 per cent. above the mean.

The figures for 1910, when compared with those of earlier years in the past half-century, show a much greater uniformity in the seasonal mortality, since serious epidemics have not prevailed in the State either in the past year or in any of the years of the past decade.

Death-rates of Cities and Large Towns. — In Table II., last column, the death-rates of cities and towns having over 5,000 inhabitants are given. These death-rates are obtained by comparing the deaths in each city and town with the census population. They vary from a minimum of 9.2 in Bridgewater to 19.8 per 1,000 in Lowell.

The following cities and towns had death-rates above 19 per 1,000 in 1910; Lowell, 19.8; Taunton, 19.7; Fairhaven, 19.5; Milford, 19.5; Reading, 19.4; Grafton, 19.3.

Of the foregoing, Lowell and Grafton had a death-rate above 19 per 1,000 in 1909.

The following cities and towns had death-rates less than 12 per 1,000 in 1910; Marlborough, 11.8; Concord, 11.6; Quincy, 11.6; Danvers, 11.5; Brookline, 11.5; Wellesley, 11.4; Whitman, 11.3; Watertown, 11.1; Everett, 11.0; Winthrop, 10.5; Medford, 10.5; Winchester, 10.5; Westborough, 10.4; Norwood, 10.2; Bridgewater, 9.2. Of these, Brookline, Concord, Norwood, Wellesley, Westborough and Winchester had death-rates below 12 per 1,000 in 1909.

Death-rates of Certain Cities having a Population of More than 25,000. Mean Death-rates of the Seven Census Years 1870, 1875, 1880, 1885, 1890, 1895, 1900, and for 1905 and 1910.

	Mean Death-rates, 1870, 1875, 1880, 1885, 1890, 1895, and 1900.	Death-rate, 1905.	Death-rate, 1910.		Mean Death-rates, 1870, 1875, 1880, 1885, 1890, 1895, and 1900.	Death-rate, 1905.	Death-rate, 1910.
Boston, . .	23.3	18.5	17.3[1]	Haverhill, . .	17.2	15.5	17.0
Worcester, . .	19.5	17.4	17.0[1]	Salem, . .	21.4	19.5	15.9
Fall River, . .	22.8	20.2	18.5	Newton, . .	14.3	18.1	12.2
Lowell, . .	21.8	20.0	19.8	Fitchburg, .	16.4	13.1	13.4
Cambridge, .	19.0	15.5	15.4	Taunton, . .	19.7	21.8	23.4[1]
New Bedford, .	20.7	17.2	18.8	Everett, . .	15.4	13.9	11.0
Lynn, . . .	17.4	16.2	13.1	Quincy, . .	17.1	13.1	11.7
Springfield, . .	19.0	15.2	16.7	Chelsea, . .	19.7	18.4	18.6[1]
Lawrence, . .	21.7	19.6	17.7	Pittsfield, . .	17.5	16.6	17.7
Somerville, . .	17.1	14.0	13.5	Waltham, . .	15.0	13.7	14.0
Holyoke, . .	22.2	16.3	17.8	Chicopee, . .	20.8	17.7	15.4
Brockton, . .	15.3	12.7	12.4	Gloucester, .	20.6	14.8	16.0[2]
Malden, . .	16.4	13.3	13.1				

[1] These figures for Boston, Chelsea, Worcester and Taunton include all deaths. By exclusion of deaths of non-residents in Boston and deaths in public and private institutions in the other 3 cities, the death-rates would be reduced to 13.3 in Chelsea, 15.4 in Boston, 19.7 in Taunton and 15.7 in Worcester.

[2] Gloucester has been allowed to stand in this list, although it has dropped below the 25,000 mark during the past five years.

Causes of Death. — In Table III. the mortality of the cities and towns embraced in this summary is presented in absolute figures, classified according to the principal causes of death. The same figures are again presented in relative terms in Table IV., for the whole group of cities and towns combined. Two sets of figures are given in Table IV., in one of which the mortality from each principal cause of death is compared with the census population of the group for 1910, as well as for each of the last five years, and in the other with the total mortality of the group of cities and towns.

By this it appears that the general death-rate from all causes, as shown in the lower line at the left of the table, 160.43 per 10,000 living, or, as usually stated, 16.04 per 1,000, was slightly higher than that of 1909, but lower than in the years 1908, 1907 and 1906, when it was 16.40, 17.46 and 16.61, respectively. The population comprised in these returns constitutes about 89 per cent. of that of the whole State.

The decline in the general death-rate during the year 1910 is chiefly due to a decrease in the relative number of deaths from infective diseases, more especially to the gastro-intestinal diseases of infancy and childhood.

The death-rate from each of the following causes was less than that of 1909: consumption, scarlet fever, diphtheria and croup, whooping cough, typhoid fever, cerebro-spinal meningitis, puerperal fever, malarial fever, dysentery, diarrhœa and cholera morbus and suicide. That of consumption, diphtheria and croup, whooping cough, cerebro-spinal meningitis, malarial fever, diarrhœa and cholera morbus was also less than the death-rates from the same causes in any of the last five years.

The following table, first published in the report of 1899, presents the combined death-rate from eight of the principal infective diseases, and also shows that this combined death-rate in 1910 was less than that of any of the years embraced in this series of reports.

The diseases referred to are consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum.

The combined death-rate per 10,000 of the population from these eight causes for the sixteen years (1895–1910) in the cities and towns included in this report (about seven-eighths of the total population of the State) was as follows: —

Combined Death-rate from Eight Principal Infective Diseases.

YEAR.	Combined Death-rate per 10,000.	YEAR.	Combined Death-rate per 10,000.
1895,	46.4	1903,	30.7
1896,	46.8	1904,	27.0
1897,	39.7	1905,	28.0
1898,	36.3	1906,	27.9
1899,	35.2	1907,	27.8
1900,	40.7	1908,	28.5
1901,	33.5	1909,	27.1
1902,	30.9	1910,	26.1

The death-rate from consumption was lower in 1910 than in any year of record, being 12.60, as against 13.38 in 1909, 13.49 in 1908, 15.50 in 1907, and 15.11 in 1906.

The seasonal table which appeared in the earlier reports, presenting the deaths by months for each city and town and for the whole State, is omitted in the present report, since the details presented in this table are not of essential value. Its chief value consisted in the column of total figures for the State, which is retained essentially in the table on page 593.

The table of percentages of total mortality shown in Table IV. acts in a measure as a check or control in case of erroneous estimates of population.

The changes in the death-rate from consumption, typhoid fever and puerperal fever (see child-birth in report of 1896, page 804) were quite fully treated in the report of 1896. To these may be added the later comments on the changes in the death-rate from diphtheria, which appear in the figures of the past sixteen years.

The following preventable causes of death, consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum, together constituted 27.2 per cent. of the total mortality in 1894, but had fallen off to 24.2, 24.2, 21.9, 21.1, 20.4, 22.3, 19.9, 19, 19, 17.5, 16.7, 16.8, 15.9, 17.4, 17.0 and 16.3 in the sixteen succeeding years; while the principal acute lung diseases, diseases of the heart, brain, kidneys, cancer, suicide and accident had increased from 35.7 per cent. of the total mortality to 36.9, 36.9, 38.5, 39.2, 40.2, 38.6, 40.1, 42.7, 43, 45.7, 46.6, 45.6, 46.3, 46.7, 47.5 and 50.3 in the same years.

These all combined constituted the greater part of the total mortality in each of the seventeen years 1894–1910, and of the diseases specified in the table entitled the "Balance of Mortality," in the annual report of 1896, page 812.

TABLE I.

Population of Cities and Large Towns, Census of 1910.

REPORTING CITIES AND TOWNS.	Population 1910.	REPORTING CITIES AND TOWNS.	Population 1910.
Abington, ...	5,455	Arlington, ...	11,187
Adams, ...	13,026	Athol, ...	8,536
Amesbury, ...	9,894	Attleborough, ...	16,215
Amherst, ...	5,112	Belmont, ...	5,542
Andover, ...	7,301	Beverly, ...	18,650

Table I. — *Continued.*

Reporting Cities and Towns.	Population 1910.	Reporting Cities and Towns.	Population 1910.
Blackstone,	5,648	Ludlow,	4,948
Boston,	670,585	Lynn,	89,336
Braintree,	8,066	Malden,	44,404
Bridgewater,	7,688	Mansfield,	5,183
Brockton,	56,878	Marblehead,	7,338
Brookline,	27,792	Marlborough,	14,579
Cambridge,	104,839	Maynard,	6,390
Chelmsford,	5,010	Medford,	23,150
Chelsea,	32,452	Melrose,	15,715
Chicopee,	25,401	Methuen,	11,448
Clinton,	13,075	Middleborough,	8,214
Concord,	6,421	Milford,	13,055
Danvers,	9,407	Milton,	7,924
Dedham,	9,284	Monson,	4,758
Easthampton,	8,524	Montague,	6,866
Easton,	5,139	Natick,	9,866
Everett,	33,484	Needham,	5,026
Fairhaven,	5,122	New Bedford,	96,652
Fall River,	119,295	Newburyport,	14,949
Fitchburg,	37,826	Newton,	39,806
Framingham,	12,948	North Adams,	22,019
Franklin,	5,641	Northampton,	19,431
Gardner,	14,699	North Andover,	5,529
Gloucester,	24,398	North Attleborough,	9,562
Grafton,	5,705	Northbridge,	8,807
Great Barrington,	5,926	Norwood,	8,014
Greenfield,	10,427	Orange,	5,282
Haverhill,	44,115	Palmer,	8,610
Hingham,	4,965	Peabody,	15,721
Holyoke,	57,730	Pittsfield,	32,121
Hudson,	6,743	Plymouth,	12,141
Hyde Park,	15,507	Quincy,	32,642
Ipswich,	5,777	Reading,	5,818
Lawrence,	85,892	Revere,	18,219
Leominster,	17,580	Rockland,	6,928
Lexington,	4,918	Salem,	43,697
Lowell,	106,294	Saugus,	8,047

TABLE I. — *Concluded.*

REPORTING CITIES AND TOWNS.	Population 1910.	REPORTING CITIES AND TOWNS.	Population 1910.
Somerville,	77,236	Webster,	11,509
Southbridge,	12,592	Wellesley,	5,413
South Hadley,	4,894	Westborough,	5,446
Spencer,	6,740	Westfield,	16,044
Springfield,	88,926	West Springfield,	9,224
Stoneham,	7,090	Weymouth,	12,895
Stoughton,	6,316	Whitman,	7,292
Swampscott,	6,204	Williamstown,	3,708
Taunton,	34,259	Winchendon,	5,678
Wakefield,	11,404	Winchester,	9,309
Walpole,	4,892	Winthrop,	10,132
Waltham,	27,834	Woburn,	15,308
Ware,	8,774	Worcester,	145,986
Watertown,	12,875	Total,	2,982,294

TABLE II.

Total Deaths, Deaths by Sexes, Age Periods and Still-births in Cities and Towns having over 5,000 Inhabitants in Each with General Death-rates according to the Census of 1910.

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Abington, ...	76	32	43	1	1	9	1	1	-	1	-	1	1	1	4	10	8	11	15	13	-	13.92
Adams, ...	176	95	81	-	11	65	11	5	3	-	3	-	6	6	9	8	16	22	16	6	-	13.51
Amesbury, ...	185	90	95	-	13	33	5	4	1	1	4	3	2	10	12	20	18	22	28	22	-	18.71
Amherst, ...	85	39	46	-	2	9	3	-	-	-	-	1	-	1	3	7	12	15	20	14	-	16.63
Andover, ...	112	53	59	-	9	13	1	1	1	-	3	3	3	4	4	9	16	18	21	15	-	15.34
Arlington, ...	176	86	90	-	7	23	1	-	2	1	5	2	5	9	16	15	27	28	23	19	-	15.73
Athol, ...	145	72	72	1	4	17	2	2	1	-	9	-	3	9	8	9	14	19	29	23	-	16.98
Attleborough, . . .	204	96	108	-	11	41	20	4	3	1	3	1	5	13	13	16	14	22	30	16	2	12.58
Belmont, ...	68	26	42	-	2	9	1	1	1	1	1	1	1	5	9	6	6	12	10	4	-	12.27
Beverly, ...	270	140	130	-	22	36	7	-	1	2	5	2	10	18	19	24	26	40	49	31	-	14.48
Blackstone, . . .	94	54	40	-	3	15	5	1	1	-	2	5	1	5	6	7	5	22	9	9	1	16.64
Boston,[1]	11,573	6,051	5,522	-	675	2,249	462	193	137	79	244	160	221	752	1,122	1,316	1,369	1,507	1,148	612	2	15.35[2]
Braintree, . . .	123	64	59	-	6	16	5	-	-	1	7	-	3	3	5	9	13	17	24	19	1	15.24
Bridgewater,[3] . . .	71	34	37	-	3	12	2	2	1	-	1	-	-	5	-	4	8	11	17	8	-	9.23[4]
Brockton, . . .	707	360	347	-	60	135	25	6	5	11	22	11	18	37	55	48	73	93	100	68	-	12.43
Brookline, . . .	321	141	180	-	14	28	4	-	-	2	3	2	2	15	23	21	47	65	67	42	-	11.55

Cambridge, ...	1,618	822	796	-	85	327	66	26	16	13	23	31	32	110	140	149	182	223	168	111	1	15.43
Chelmsford, ...	90	43	47	-	5	12	1	-	3	1	2	2	1	3	10	6	9	12	13	15	-	17.96
Chelsea,[4]	605	404	201	-	40	107	19	3	3	1	3	1	11	43	50	41	54	110	101	55	3	18.34[3]
Chicopee, ...	392	199	193	-	32	142	36	8	6	3	5	4	3	18	26	24	33	31	36	18	-	15.43
Clinton, ...	174	94	80	-	12	33	9	4	3	-	2	6	3	12	13	14	22	18	24	11	-	13.30
Concord, ...	75	44	31	-	5	11	-	-	-	-	1	8	6	1	13	6	8	8	9	8	1	11.68
Danvers,[5]	109	50	59	-	9	15	-	-	-	2	-	1	3	6	7	9	4	25	19	17	1	11.58[3]
Dedham, ...	132	77	55	-	10	19	9	1	2	1	3	2	3	12	7	8	18	11	22	14	-	14.22
Easthampton, . . .	116	60	56	-	9	38	5	3	4	2	1	1	2	7	9	8	3	10	14	9	-	13.62
Easton, ...	66	34	32	-	1	8	1	-	-	-	-	-	2	3	4	6	6	16	15	5	-	12.84
Everett, ...	369	195	174	-	36	67	11	5	3	-	9	8	11	17	31	35	38	59	46	29	-	11.02
Fairhaven, ...	100	45	55	-	6	18	9	3	1	3	5	2	2	5	4	4	11	5	14	14	-	19.53
Fall River, ...	2,210	1,141	1,069	-	191	859	168	33	27	18	44	17	44	119	147	145	185	202	145	57	-	18.52
Fitchburg, ...	505	253	252	-	37	133	24	8	10	6	13	9	13	33	31	40	38	65	49	33	-	13.35
Framingham, . . .	215	112	103	-	12	31	6	2	1	1	5	4	4	20	14	15	31	22	35	23	1	16.60
Franklin, ...	78	35	43	-	3	14	2	-	-	1	2	2	1	5	2	3	7	13	12	14	-	13.83
Gardner, ...	229	134	95	-	32	55	14	2	3	2	6	4	3	18	16	11	26	32	14	22	1	15.58
Gloucester, ...	391	189	202	-	26	50	8	4	3	1	13	9	8	26	33	27	45	64	61	39	-	16.02
Grafton, ...	110	64	46	-	2	12	2	1	1	1	3	-	1	4	10	8	14	21	17	15	-	19.26
Great Barrington, . .	100	53	47	-	4	19	4	1	-	1	1	-	1	6	10	7	4	14	24	8	-	16.86
Greenfield, ...	161	83	78	-	15	20	5	1	1	-	3	3	2	9	14	13	20	25	25	20	-	15.44
Haverhill, ...	751	378	373	-	58	127	32	16	5	4	11	10	20	46	70	72	79	97	101	61	-	17.02
Hingham, ...	78	28	50	-	4	8	1	-	1	-	2	-	-	1	3	6	8	12	15	21	-	15.69

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[1] Non-residents, 1,280, included.

[2] State Farm, 129, additional.

[3] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.

[4] Soldiers' Home and Marine and Naval Hospitals, 172, included.

[5] Insane asylum, 195, additional.

TABLE II. — *Continued.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Holyoke, ...	1,026	524	502	-	79	363	67	19	12	8	22	18	27	73	75	76	74	101	65	26	-	17.77
Hudson, ...	82	43	39	-	11	16	-	2	-	-	-	2	-	5	7	6	7	9	16	12	-	12.17
Hyde Park, ...	262	148	114	-	18	59	17	4	1	2	5	2	7	11	15	20	29	29	36	22	3	16.89
Ipswich, ...	103	54	49	-	7	21	5	3	2	1	2	4	9	11	3	8	12	-	15	7	-	17.99
Lawrence, ...	1,524	773	751	-	133	527	106	45	16	17	28	8	24	87	105	107	125	153	124	51	1	17.74
Leominster, ...	253	123	130	-	17	50	6	5	1	1	5	3	4	12	23	21	23	42	36	20	1	14.39
Lexington, ...	61	32	29	-	3	6	-	3	-	-	-	-	-	7	6	5	6	10	12	6	-	12.40
Lowell, ...	2,100	1,045	1,055	-	136	607	125	47	34	22	45	20	39	124	158	171	177	242	183	106	-	19.76
Ludlow, ...	79	47	32	-	7	30	8	-	1	-	1	-	4	8	5	6	6	4	5	1	-	15.96
Lynn, ...	1,173	605	568	-	108	211	49	16	9	7	24	18	15	77	86	111	131	178	147	92	2	13.13
Malden, ...	581	278	303	-	35	103	11	7	3	5	16	10	13	43	37	53	51	72	89	68	-	13.09
Mansfield, ...	88	47	41	-	8	8	1	1	1	-	-	2	4	7	2	6	10	12	19	14	1	16.99
Marblehead, ...	137	63	74	-	7	13	2	-	-	-	1	-	1	2	10	10	14	17	38	29	-	18.66
Marlborough, . . .	173	88	85	-	4	34	-	3	1	-	6	1	6	11	9	14	10	37	23	18	-	11.81
Maynard, ...	81	42	39	-	11	26	2	-	3	2	2	-	4	1	5	5	4	8	12	7	-	12.68
Medford, ...	244	118	126	-	21	30	4	-	-	-	5	4	1	15	16	28	32	35	45	29	-	10.54
Melrose, ...	205	87	118	-	11	36	5	3	2	1	1	1	5	18	11	16	18	36	35	22	-	13.04
Methuen, ...	186	85	101	-	17	35	7	2	2	3	7	2	8	15	17	7	18	23	27	13	1	16.24

Middleborough, . .	111	59	52	-	2	11	4	1	2	1	5	2	4	7	2	4	7	19	17	25	-	13.52
Milford, ...	254	133	121	-	22	57	7	6	5	3	2	3	6	13	24	23	25	29	20	22	-	10.46
Milton, ...	110	55	55	-	4	12	1	2	-	3	3	-	1	8	10	10	13	19	16	12	-	13.89
Monson,[1]	59	38	21	-	1	11	-	3	1	-	2	1	-	5	5	4	3	5	13	6	-	12.39[2]
Montague, . . .	121	57	64	-	6	26	5	-	1	3	3	3	3	4	12	9	14	9	14	14	1	17.61
Natick, ...	149	73	76	-	11	7	1	2	-	-	1	3	2	8	9	11	14	36	33	22	-	15.10
Needham, . . .	75	39	36	-	5	16	4	2	1	-	4	2	2	4	7	3	6	4	11	9	-	14.91
New Bedford, . . .	1,817	953	864	-	137	690	122	40	24	18	43	13	41	111	103	101	121	157	154	79	-	18.80
Newburyport, . . .	283	140	143	-	15	45	8	2	1	-	5	7	8	15	14	15	20	47	52	44	-	18.93
Newton, ...	485	218	267	-	22	79	15	7	2	4	5	4	7	28	27	45	43	82	83	54	-	12.18
North Adams, . . .	321	189	132	-	23	55	11	6	2	4	14	4	4	24	23	32	31	42	45	24	-	14.58
Northampton,[3] . .	365	202	163	-	10	44	4	3	1	1	7	3	5	25	28	30	42	58	71	43	-	12.92[2]
North Andover, . .	84	46	38	-	10	13	4	2	1	-	1	-	1	3	7	9	8	18	13	4	-	15.19
North Attleborough, .	132	66	66	-	13	32	8	5	2	-	1	1	2	4	6	10	10	23	14	14	-	13.81
Northbridge, . . .	153	74	79	-	12	43	5	1	3	2	6	2	2	12	14	13	12	13	17	8	-	17.37
Norwood, . . .	82	48	34	-	17	20	4	2	1	1	1	-	-	5	5	5	7	8	11	12	-	10.24
Orange, ...	65	27	38	-	6	9	-	-	1	-	2	-	2	2	1	2	8	14	12	12	-	12.31
Palmer, ...	152	81	71	-	13	51	14	8	7	3	6	1	2	12	8	2	6	10	12	10	-	17.65
Peabody, ...	221	118	103	-	15	42	5	1	2	-	2	2	3	19	21	24	22	38	24	15	1	14.06
Pittsfield, . . .	583	323	260	-	29	109	13	13	7	4	13	9	13	55	33	56	63	77	70	46	2	18.15
Plymouth, . . .	215	111	104	-	8	40	1	2	2	-	7	4	3	7	8	22	14	34	39	32	-	17.71
Quincy, ...	381	201	180	-	32	86	18	3	4	-	11	3	12	26	28	28	34	48	50	28	2	11.67
Reading, ...	113	54	59	-	6	12	2	1	1	-	1	2	1	1	7	8	12	17	32	16	-	19.42

[1] Epileptic hospital, 49 additional.

[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.

[3] Non-residents, 114, included.

TABLE II. — *Concluded.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Revere, ...	219	104	115	-	14	61	18	5	2	2	4	2	2	8	19	17	32	13	20	14	-	12.02
Rockland, . . .	85	53	32	-	3	10	3	1	2	-	2	1	2	5	4	5	13	13	14	10	-	12.27
Salem, ...	696	339	354	3	48	146	24	9	8	3	15	14	9	53	47	60	77	97	86	45	3	15.93
Saugus, ...	119	56	63	-	6	23	2	2	2	2	4	1	2	12	4	13	15	12	11	14	-	14.78
Somerville, . . .	1,043	497	546	-	61	175	24	14	17	10	17	11	14	55	70	74	126	178	169	89	-	13.50
Southbridge, . . .	179	96	82	1	14	58	15	5	3	2	8	-	3	5	13	3	13	20	24	7	-	14.22
South Hadley, . . .	59	30	29	-	2	15	1	-	-	-	3	-	2	3	4	3	3	11	7	7	-	12.07
Spencer, ...	93	53	40	-	3	12	1	-	-	-	-	-	4	6	10	3	10	16	16	15	-	13.80
Springfield, . . .	1,481	790	691	-	94	303	65	37	26	22	41	20	34	98	107	133	142	189	166	98	-	16.65
Stoneham, . . .	118	55	63	-	2	14	-	2	1	-	-	-	-	7	7	3	12	26	25	21	-	16.64
Stoughton, . . .	90	49	41	-	5	13	-	3	1	1	1	-	2	9	8	4	7	11	14	16	-	14.24
Swampscott, . . .	88	44	44	-	4	12	2	-	-	-	-	2	1	7	5	4	5	13	21	16	-	14.19
Taunton,[1] . . .	801	426	375	-	36	200	29	16	7	4	26	10	8	45	43	74	91	96	95	57	-	19.67[2]
Wakefield, . . .	158	82	76	-	7	27	5	2	1	-	4	1	1	9	11	14	19	21	28	15	-	13.86
Walpole, ...	65	35	30	-	4	9	2	3	-	-	1	-	-	3	3	6	10	8	10	10	-	13.29
Waltham, ...	389	186	203	-	23	44	10	3	6	3	24	6	9	36	21	33	47	56	55	34	2	13.98
Ware, ...	128	71	57	-	13	20	11	3	1	2	5	4	4	9	5	10	15	9	13	17	-	14.60
Watertown, . . .	144	71	73	-	16	37	4	3	2	1	1	3	1	7	9	10	17	16	17	10	-	11.18

Webster,	178	92	86	-	7	56	13	3	1	3	6	3	1	12	8	10	13	13	25	10	1	15.46
Wellesley,	52	29	23	-	3	6	1	-	-	-	1	-	2	1	3	6	5	7	9	11	-	11.46
Westborough,[3]	169	91	78	-	2	6	1	-	-	1	1	1	1	5	14	28	31	30	31	17	2	10.46[2]
Westfield,	236	133	103	-	30	56	15	3	6	3	2	2	5	8	11	12	27	39	27	20	-	14.71
West Springfield,	129	74	55	-	8	33	6	1	4	-	2	7	3	3	7	14	7	12	18	12	-	13.99
Weymouth,	219	102	117	-	8	25	11	2	-	2	-	-	5	5	14	23	24	28	47	33	-	16.98
Whitman,	83	36	43	4	2	15	1	1	-	1	-	2	2	4	4	5	5	15	13	15	-	11.39
Williamstown,	58	24	34	-	4	10	-	-	1	-	1	-	2	5	4	3	8	7	13	4	-	15.63
Winchendon,	101	45	56	-	5	26	5	1	1	1	3	-	1	1	4	4	12	10	15	17	-	17.78
Winchester,	98	48	50	-	4	8	1	3	-	-	3	4	4	5	5	7	11	14	21	12	-	10.53
Winthrop,	107	49	58	-	6	16	2	-	2	-	1	3	1	4	7	12	12	23	5	9	-	10.56
Woburn,	236	125	111	-	10	43	7	9	2	1	3	2	3	9	15	21	24	38	34	25	-	15.42
Worcester,[4]	2,476	1,307	1,169	-	167	539	100	41	27	25	47	28	43	176	218	206	260	315	295	136	20	15.66[2]
	47,846	24,669	23,167	10	3,140	10,538	2,037	785	532	366	1,010	602	923	2,952	3,668	4,142	4,891	6,190	5,698	3,455	57	16.04

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[1] Insane asylum, 127 included.

[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.

[3] Insane hospital, 112, included.

[4] Insane hospitals, 190, included.

TABLE III.

Deaths from Specified Causes in Cities and Towns having more than 5,000 Inhabitants in Each, 1910.

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Abington, . . .	5	-	-	-	-	-	1	-	-	-	-	-	-	-	-	5	1	20	9	10	4	-	3	-	18
Adams, . . .	10	-	1	2	5	4	-	1	-	1	2	-	27	7	2	8	9	28	14	7	4	3	9	-	32
Amesbury, . .	14	-	-	-	1	-	5	2	-	-	1	-	14	1	5	20	2	43	7	14	20	-	6	-	30
Amherst, . . .	6	-	-	-	-	-	-	1	-	-	-	-	2	-	-	7	3	24	5	6	6	-	5	-	20
Andover, . . .	6	-	1	-	1	-	1	1	-	-	-	-	1	-	1	7	8	14	17	5	9	4	5	1	30
Arlington, . . .	19	-	-	1	3	-	-	5	-	-	-	-	1	1	-	24	5	27	11	5	15	-	4	-	55
Athol, . . .	9	-	-	1	2	-	1	2	-	-	-	-	7	1	-	22	1	18	17	14	10	1	9	11	19
Attleborough, . .	9	-	2	1	1	1	3	-	-	-	4	-	2	-	18	24	2	25	9	12	11	1	8	-	71
Belmont, . . .	6	-	-	-	1	-	1	1	1	-	-	-	-	1	-	9	11	5	8	6	2	-	8	8	-
Beverly, . . .	24	-	-	-	4	-	3	-	3	-	1	-	8	2	-	23	5	39	23	30	13	3	20	-	69
Blackstone, . .	9	-	1	-	4	1	-	-	1	1	-	-	3	1	4	8	3	19	10	10	3	1	7	6	2
Boston, . . .	1,119	-	96	59	158	52	78	37	66	31	69	1	645	14	94	1,376	170	1,424	924	739	698	105	590	117	2,854
Braintree, . . .	5	-	-	-	1	-	1	-	-	-	4	1	2	-	1	12	2	26	12	8	4	3	8	-	33
Bridgewater, . .	8	-	-	1	-	-	-	3	-	-	2	-	-	-	-	7	-	10	-	-	4	1	3	-	32
Brockton, . . .	50	-	-	9	6	-	9	12	1	11	3	-	7	12	13	67	7	105	51	33	45	6	21	1	237
Brookline, . . .	11	-	-	-	1	1	1	-	1	-	-	-	1	1	1	33	2	70	25	25	36	1	2	-	109
Cambridge, .	106	-	4	5	25	5	13	4	3	2	4	-	106	3	16	228	80	193	156	82	90	11	84	-	438

Chelmsford, . . .	4	-	-	1	1	1	3	2	-	-	1	-	-	-	-	6	1	20	-	-	-	1	4	-	45
Chelsea, . . .	38	-	-	1	2	-	4	-	2	1	1	-	4	4	6	95	10	92	64	39	37	5	19	7	174
Chicopee, . . .	20	-	1	2	3	1	1	-	-	-	-	-	28	-	10	51	4	39	38	25	10	-	15	8	141
Clinton, . . .	14	-	-	-	5	-	1	-	1	-	2	-	-	2	2	17	6	11	14	7	2	2	6	1	81
Concord, . . .	4	-	-	-	-	1	-	-	-	-	1	-	-	-	-	9	-	19	10	5	4	2	8	12	-
Danvers, . . .	8	-	-	-	-	-	1	2	-	-	2	-	2	2	-	11	1	21	12	6	13	2	1	-	23
Dedham, . . .	12	-	-	-	3	-	-	4	-	-	-	-	1	-	3	10	7	17	7	5	3	1	4	-	54
Easthampton, . .	6	-	-	-	-	1	-	2	-	-	1	-	10	-	2	16	2	11	-	2	1	1	2	-	59
Easton, . . .	6	-	-	-	-	-	-	-	-	-	-	-	-	-	2	8	2	15	7	2	2	1	3	-	18
Everett, . .	38	-	1	3	5	2	3	-	1	-	2	-	4	-	3	43	6	55	27	29	26	1	20	-	99
Fairhaven, . .	8	-	1	-	8	-	-	1	-	-	-	-	5	-	2	10	4	8	5	-	4	1	1	-	42
Fall River, . .	159	-	17	2	23	12	16	1	3	-	5	-	206	6	26	269	101	178	220	122	85	5	62	19	673
Fitchburg, . .	27	-	-	5	16	-	10	-	3	-	-	-	16	4	-	62	14	51	36	25	24	5	24	5	178
Framingham, . .	15	-	-	-	2	-	1	3	-	-	2	-	4	1	1	27	8	24	17	4	13	8	10	-	75
Franklin, . . .	6	-	-	-	1	-	-	-	-	-	-	-	-	-	2	9	2	9	4	2	3	-	3	2	35
Gardner, . . .	17	-	2	-	-	-	3	-	1	-	4	-	11	-	3	28	4	18	33	13	9	1	7	-	73
Gloucester, . .	36	-	-	-	6	-	2	2	1	-	-	-	8	1	-	49	11	45	22	19	21	-	14	-	154
Grafton, . . .	12	-	5	-	2	1	-	-	-	-	-	-	1	1	1	6	7	12	2	11	2	-	4	43	-
Great Barrington, .	6	-	-	-	-	2	1	-	-	1	-	-	3	-	-	16	1	13	7	5	4	5	2	-	34
Greenfield, . .	13	-	-	-	1	3	-	-	-	-	2	-	2	1	1	16	3	19	7	16	11	3	10	-	52
Haverhill, . . .	61	-	2	4	9	7	8	8	1	2	8	-	29	3	7	135	11	60	66	59	48	5	27	6	185
Hingham, . . .	2	-	-	-	-	-	-	-	-	-	1	-	1	-	-	9	3	19	6	3	5	-	2	-	27
Holyoke, . . .	75	-	5	5	10	4	9	3	5	3	5	-	54	2	-	143	10	77	92	81	33	5	30	-	375
Hudson, . . .	4	-	-	1	1	-	-	-	-	-	1	-	1	-	10	11	1	5	10	7	7	-	5	18	-

TABLE III. — *Continued.*

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Hyde Park, . .	26	-	2	-	6	2	11	1	-	-	3	-	6	2	7	27	3	29	18	12	25	3	11	17	51
Ipswich, . . .	11	-	1	-	-	3	3	-	-	-	-	-	3	1	-	17	2	14	7	6	4	-	5	2	24
Lawrence, . . .	123	-	17	7	31	16	14	1	3	15	4	1	152	2	12	218	39	113	91	59	65	8	64	95	374
Leominster, . .	25	-	1	2	3	-	3	-	-	-	-	-	5	-	-	24	3	22	11	16	16	2	8	1	110
Lexington, . .	7	-	-	-	2	-	-	-	-	1	-	-	-	-	-	8	-	9	-	-	5	-	-	-	29
Lowell, . . .	146	-	20	38	20	6	22	6	1	1	7	1	95	9	196	224	91	304	182	109	81	19	64	2	456
Ludlow, . . .	6	-	-	-	1	-	3	-	1	-	-	-	1	4	9	15	1	8	5	3	1	-	3	-	18
Lynn, . . .	94	-	-	4	19	4	13	3	4	2	9	1	21	4	2	157	16	157	135	57	54	8	15	16	375
Malden, . . .	45	-	-	12	5	1	1	3	1	2	-	-	12	-	1	61	17	99	51	44	35	5	10	-	175
Mansfield, . . .	10	-	-	1	-	-	2	-	-	-	-	-	-	1	2	4	1	19	3	5	4	-	4	-	32
Marblehead, . .	5	-	-	-	-	-	-	-	-	-	2	-	-	-	-	16	4	28	-	6	5	3	-	-	67
Marlborough, . .	17	-	1	1	-	-	-	1	-	-	-	-	7	2	1	4	5	31	29	3	10	-	2	4	55
Maynard, . . .	6	-	-	-	-	-	-	2	2	-	-	-	3	3	4	9	1	5	4	-	2	-	4	-	36
Medford, . . .	24	-	-	1	3	-	-	-	-	-	1	-	-	-	1	34	6	24	-	20	20	4	2	-	104
Melrose, . . .	17	-	-	-	3	1	1	-	-	2	-	-	6	-	8	21	3	29	31	7	19	4	6	6	41
Methuen, . . .	19	-	-	-	1	1	4	4	-	-	1	-	5	-	1	16	4	13	5	4	6	2	10	4	86
Middleborough, .	7	-	-	-	2	-	-	2	-	-	-	-	3	1	-	10	3	24	16	2	1	-	5	-	35
Milford, . . .	13	-	1	-	2	-	-	1	1	1	3	-	9	7	-	56	5	16	7	12	11	2	7	-	100

Milton, . . .	9	-	-	-	-	-	-	-	-	-	1	-	-	-	2	14	-	7		2	4	1	4	-	66
Monson, . . .	6	-	-	-	1	-	1	-	1	-	1	-	1	-	-	5	4	6	-	5	4	-	3	7	14
Montague, . . .	10	-	-	4	2	2	-	4	-	-	-	-	6	-	-	9	4	9	5	3	5	-	6	7	45
Natick, . . .	6	-	-	-	-	-	2	-	1	-	2	-	-	1	-	21	2	30	29	8	12	-	3	-	32
Needham, . . .	8	-	-	-	-	-	-	-	1	-	-	-	-	-	2	7	-	9	7	5	3	-	5	-	28
New Bedford, . .	102	-	-	5	24	3	17	2	7	-	1	-	105	4	5	240	53	178	140	70	53	10	9	-	788
Newburyport, . .	19	-	2	-	1	-	3	1	-	-	-	-	-	-	-	41	5	11	2	16	19	1	14	1	147
Newton, . . .	28	-	-	2	4	-	3	-	1	1	6	-	-	3	17	52	5	47	79	26	35	-	15	21	139
North Adams, . .	20	-	4	3	6	-	4	5	1	-	-	-	6	-	1	35	5	28	-	21	23	4	18	1	136
Northampton, . .	33	-	-	2	2	-	1	-	3	-	5	-	13	2	7	38	4	42	57	19	18	3	7	11	98
North Andover, .	8	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	7	15	7	5	7	-	7	-	22
North Attleborough, .	11	-	-	-	2	-	1	-	-	-	2	-	13	3	3	13	12	23	11	7	9	-	4	9	9
Northbridge, . .	11	-	5	-	2	1	1	3	-	1	1	-	6	-	1	24	-	17	7	14	5	-	7	-	47
Norwood, . . .	5	-	-	-	1	1	-	1	-	-	-	-	5	-	6	9	7	18	14	7	4	1	3	-	-
Orange, . . .	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	6	4	3	7	2	5	-	2	-	32
Palmer, . . .	7	-	4	12	4	1	2	-	1	-	-	2	6	-	6	24	-	14	17	10	2	-	8	9	23
Peabody, . . .	21	-	-	-	-	-	-	1	4	1	1	-	3	3	5	22	5	33	18	14	11	5	12	-	62
Pittsfield, . . .	37	-	2	2	4	6	7	10	-	-	-	-	-	-	6	73	2	80	45	25	27	2	52	74	129
Plymouth, . .	14	-	-	-	2	-	5	3	2	-	3	-	2	1	2	15	2	41	23	11	22	1	8	-	58
Quincy, . . .	44	-	4	3	3	1	3	-	2	4	-	-	5	2	21	58	4	69	32	16	18	6	19	26	37
Reading, . . .	3	-	-	1	1	-	-	2	-	-	-	-	1	-	1	17	1	19	31	-	3	-	2	8	23
Revere, . . .	19	-	-	2	-	4	-	-	1	1	1	-	3	10	-	22	14	20	-	4	7	3	4	1	103
Rockland, . . .	9	-	-	-	-	-	1	1	2	-	-	-	3	3	3	6	1	11	3	2	14	1	5	-	20
Salem, . . .	79	-	-	3	7	4	3	1	1	-	-	-	16	5	3	85	19	95	55	39	26	2	26	3	224

TABLE III. — *Concluded.*

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Illdefined Causes.	All Other Causes.
Saugus, . . .	6	-	1	1	1	1	1	4	1	-	-	-	2	-	-	22	-	17	1	6	3	2	5	7	38
Somerville, . .	76	-	3	5	20	-	6	2	9	-	6	-	10	2	3	150	22	108	81	90	82	5	36	-	327
Southbridge, . .	13	-	-	3	5	-	2	2	-	-	-	-	15	1	1	17	7	13	11	10	10	1	3	28	37
South Hadley, . .	6	-	-	-	-	-	-	1	1	-	1	-	2	-	-	7	-	4	3	2	-	1	2	2	27
Spencer, . . .	5	-	-	-	-	2	-	2	-	1	-	-	2	-	-	10	3	22	19	4	6	-	5	8	4
Springfield, . .	72	-	12	19	38	23	13	3	2	5	16	-	95	2	12	173	19	114	126	172	84	19	63	24	371
Stoneham, . .	5	-	-	-	-	-	-	-	-	-	1	-	-	2	2	11	2	27	14	7	13	2	4	28	-
Stoughton, . .	10	-	-	-	-	-	-	-	-	-	2	-	6	1	-	12	1	12	12	9	6	-	2	7	10
Swampscott, . .	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	2	16	3	4	3	-	1	-	49
Taunton, . . .	40	-	4	1	8	1	7	2	6	4	9	-	27	2	89	78	55	44	96	29	38	4	25	-	232
Wakefield, . . .	27	-	-	2	-	1	1	-	-	-	-	-	2	1	-	19	2	26	30	5	11	-	2	-	29
Walpole, . . .	5	-	-	-	1	1	-	1	-	-	-	-	1	-	-	9	1	4	6	6	-	-	2	-	28
Waltham, . . .	25	-	-	-	12	2	3	-	2	-	5	-	2	3	1	50	4	57	59	16	18	1	12	15	100
Ware, ...	9	-	-	-	1	-	1	3	-	-	-	-	5	-	-	22	3	20	12	7	6	-	6	12	21
Watertown, . .	12	-	1	1	1	-	1	1	1	-	1	-	-	2	-	16	1	20	5	8	6	1	7	1	62
Webster, . . .	13	-	3	-	3	1	-	-	-	-	3	-	3	4	27	16	2	11	14	16	6	1	4	1	50
Wellesley, . . .	5	-	-	-	-	-	-	-	1	-	1	-	-	-	-	4	1	10	2	2	3	-	4	-	10
Westborough, . .	11	-	-	-	3	-	1	-	2	-	-	-	-	-	5	20		26	54	9	8	5	6	3	7

Westfield,	9	-	-	-	12	-	3	-	-	-	2	-	-	-	-	38	10	30	7	11	8	2	12	-	02
West Springfield,	8	-	-	-	4	2	-	7	-	-	2	-	2	4	-	12	6	13	8	13	-	2	7	-	30
Weymouth,	19	-	-	-	1	-	1	-	1	-	-	-	3	-	-	25	6	50	35	19	6	1	4	4	44
Whitman,	7	-	-	-	2	-	-	1	-	-	-	-	1	1	-	3	2	15	12	3	6	-	-	-	30
Williamstown,	1	-	-	-	-	-	-	-	-	-	1	-	3	-	-	10	1	7	6	6	3	-	2	-	18
Winchendon,	5	-	4	-	1	-	-	3	-	-	-	-	4	-	1	11	1	15	4	4	7	1	2	-	38
Winchester,	6	-	-	-	1	-	-	-	1	-	2	-	1	-	4	4	3	15	7	7	15	-	6	7	19
Winthrop,	6	-	-	-	2	-	-	2	-	-	-	-	-	-	2	9	5	13	9	13	9	2	5	5	25
Woburn,	22	-	-	1	3	3	1	-	2	-	-	-	2	-	3	22	9	27	7	11	12	2	6	4	99
Worcester,	148	-	24	5	49	34	23	24	11	12	9	-	240	-	30	282	33	254	248	104	139	11	114	-	680
	3,757	-	255	246	644	227	375	213	175	107	243	7	2,166	172	751	5,761	1,045	5,687	4,079	2,777	2,544	357	1,835	741	13,591

	Homicide.
Boston,	42
Brockton,	1
Danvers,	2
Dedham,	1
Gardner,	2
Leominster,	1
Lynn,	3
Malden,	1
New Bedford,	1
Newton,	1
Quincy,	3
Springfield,	4
Waltham,	1
Watertown,	1
Worcester,	2
	66

	Tetanus.
Boston,	15
Everett,	1
Greenfield,	1
Quincy,	1
Waltham,	1
	19

	Glanders.
Boston,	2

	Anthrax.
Boston,	1

	Actinomycosis.
Boston,	1

	Beri-beri.
Boston,	1

	Pellagra.
Marblehead,	1

TABLE IV.

Deaths from Specified Causes, 1910, in Cities and Towns required to report to the State Board of Health, Death-rates per 10,000 (1906–10) Deaths per 1,000 from All Causes, 1906–10.

CAUSES OF DEATH.	Deaths 1910.	MORTALITY PER 10,000 OF THE POPULATION.					DEATHS PER 1,000 FROM ALL CAUSES.				
		1910	1909	1908	1907	1906	1910	1909	1908	1907	1906
Consumption,	3,757	12.60	13.38	13.49	15.50	15.11	78.52	84.07	82.20	88.75	91.00
Smallpox,	–	–	0.0036	0.02	0.01	–	–	0.022	0.13	0.09	–
Measles,	255	0.86	0.66	1.22	0.55	0.58	5.33	4.14	7.43	3.13	3.49
Scarlet fever,	246	0.82	0.88	1.15	1.00	0.43	5.14	5.55	7.02	5.72	2.60
Diphtheria and croup,	644	2.16	2.37	2.45	2.61	2.50	13.46	14.89	14.95	14.90	15.03
Whooping cough,	227	0.76	0.92	1.01	0.81	1.72	4.74	5.76	6.13	4.65	10.35
Typhoid fever,	375	1.26	1.35	1.76	1.25	1.64	7.84	8.49	10.76	7.14	9.87
Cerebro-spinal meningitis.	213	0.71	0.82	0.93	1.98	1.78	4.45	5.12	5.68	11.36	10.71
Erysipelas,	175	0.59	0.55	0.40	0.49	0.43	3.66	3.48	2.45	2.81	2.58
Puerperal fever,	107	0.36	0.37	0.33	0.39	0.28	2.24	2.34	2.02	2.23	1.71
Influenza,	243	0.81	0.80	1.04	1.56	0.51	5.08	5.03	6.33	8.91	3.08
Malarial fever,	7	0.02	0.05	0.03	0.08	0.06	0.15	0.32	0.16	0.47	0.36
Cholera infantum,	2,166	7.26	7.19	7.08	5.71	5.59	45.27	45.14	43.18	32.67	33.70
Dysentery,	172	0.58	0.60	0.53	0.53	0.58	3.59	3.78	3.21	3.04	3.49
Diarrhœa and cholera morbus.	751	2.52	2.53	3.07	4.73	4.10	15.70	15.87	18.70	27.06	24.72
Pneumonia,	5,761	19.32	16.82	16.88	17.98	17.72	120.42	105.67	102.94	102.98	106.72
Bronchitis,	1,045	3.50	3.46	3.63	4.31	4.19	21.80	21.74	22.16	24.68	25.27
Diseases of the heart,	5,687	19.07	17.33	17.36	18.43	17.00	118.85	108.88	105.84	105.52	102.40
Diseases of the brain and spinal cord.	4,079	13.68	13.50	14.03	14.10	12.46	85.28	84.79	85.57	80.72	75.03
Diseases of the kidneys,	2,777	9.31	8.96	8.46	9.15	8.95	58.04	56.27	51.58	52.38	53.90
Cancer,	2,544	8.53	8.33	8.47	8.37	8.13	53.17	52.33	51.64	47.93	48.98
Suicide,	357	1.20	1.25	1.36	1.35	1.00	7.46	7.85	8.29	7.74	6.01
Accident,	1,835	6.15	6.03	6.37	7.19	6.29	38.35	37.86	38.82	41.16	37.87
Unknown or ill-defined causes.	741	2.48	1.51	2.79	2.15	1.98	15.49	9.47	17.02	12.30	11.95
All causes,	47,846	160.43	159.17	164.00	174.65	166.10	–	–	–	–	–

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Public Document **No. 56**

SEVENTEENTH ANNUAL REPORT

OF THE

BOARD OF REGISTRATION IN MEDICINE.

For the Year ending Dec. 31, 1910.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 Post Office Square.
1911.

APPROVED BY

THE STATE BOARD OF PUBLICATION.

The Commonwealth of Massachusetts.

BOARD OF REGISTRATION IN MEDICINE,
STATE HOUSE, Dec. 15, 1910.

To His Excellency EBEN S. DRAPER, *Governor.*

SIR: — We have the honor to present the seventeenth annual report of this department, for the year ending Nov. 30, 1910.

FINANCIAL STATEMENT.

Appropriations.

Salaries of members of the Board,	$4,300 00	
Incidental expenses of the Board,	500 00	
Clerical service,	800 00	
Contingent expenses, including printing of annual report,	950 00	
		$6,550 00

Expenditures.

Salaries of members of the Board,	$4,300 00	
Incidental expenses of the Board,	395 27	
Clerical services,	800 00	
Contingent expenses including printing, office supplies, postage, etc.,	799 31	
		$6,294 58

Receipts.

270 examination fees received and paid into the treasury of the Commonwealth,	$5,400 00

For the year ending November, 1911, the Board recommends an appropriation of $4,300 for salaries, $450 for incidental expenses of the Board, $800 for clerical service, and $900 for printing, postage, office supplies and contingent expenses, including printing of annual report, the total being $100 less than the amount appropriated for the year 1910.

The number of persons applying for registration this year, under chapter 76 of the Revised Laws, is 270, all of whom have been examined except 1. Of this number, 246 are graduates from medical schools authorized to confer degrees in medicine and 24 were undergraduates. The percentage of graduates registered on first examination is 79; of undergraduates, 16.

Of the graduates (246) applying and examined this year, 202 have been registered, 196 by first examination and 6 by re-examination; 44 are on the rejected list. Of the undergraduates (23) applying and examined this year, only 6 have been registered, 5 by first examination and 1 by re-examination; 17 are on the rejected list. The percentages occurring in each examination are shown by the following tabulations: —

GRADUATES AND UNDERGRADUATES.	Examined.	Registered.	Rejected.	Percentage rejected.
March examination, ...	74	37	37	50
May examination, ...	36	18	18	50
July examination, ...	135	94	41	30
September examination, ...	56	24	32	57
November examination, ...	72	41	31	43
	364	214	159	46

GRADUATES.	Examined.	Registered.	Rejected.	Percentage rejected.
March examination, ...	64	37	27	42
May examination, ...	30	16	14	40
July examination, ...	125	92	33	26
September examination, ...	47	23	24	51
November examination, ...	60	40	20	33
	326	208	118	38

UNDERGRADUATES.	Examined.	Registered.	Rejected.	Percentage rejected.
March examination, ...	10	-	10	100
May examination, ...	6	2	4	66
July examination, ...	10	2	8	80
September examination, ...	9	1	8	88
November examination, ...	12	1	11	83
	47	6	41	83

The following tabulation is based upon the results in the first examination of graduates during the year covered by this report: —

MEDICAL INSTITUTIONS.	Number examined.	Number registered.	Year of Graduation of Rejected Applicants.
Tufts,	69	62	1909-09-10-10-10-10-10
Harvard,	44	42	1909-09.
Physicians and Surgeons, Boston,	23	5	1908-08-08-08-08-08-08-09-09-09-09-09-09-10-10-10-10-10.
Massachusetts College of Osteopathy,	19	14	1906-09-09-09-10.
Boston University,	13	13	
Dartmouth,	10	9	1909.
Foreign,	10	6	1900-06-06-09.
Baltimore Medical,	6	4	1909-10.
University of Maryland,	6	5	1910.
Maryland Medical,	5	1	1908-09-10-10.
Medical School of Maine,	5	4	1910.
McGill,	4	4	
University of Pennsylvania,	4	4	
University of Vermont,	3	3	
Laval,	3	-	1904-04-09.
Physicians and Surgeons, New York,	3	3	
Johns Hopkins,	3	3	
University College of Medicine and Surgery, Virginia.	2	-	1907-07.
Georgetown University,	2	1	1907.
Howard University,	2	-	1907-09.
Physicians and Surgeons, Maryland,	2	2	
Baltimore University,	2	-	1904-06.
Jefferson,	2	2	
University of Georgia,	2	-	1901-01.
Cornell,	1	1	
Bellevue Hospital Medical College,	1	-	1893.
Leonard Medical,	1	-	1908.
University of Louisville,	1	1	
University of Chattanooga,	1	1	
Ecl. Medical Institute, Cincinnati,	1	-	1879.
S. S. Still College of Osteopathy,	1	1	
Hahnemann, Pennsylvania,	1	1	
Woman's Medical College, Pennsylvania,	1	1	
Tulane Medical,	1	1	

MEDICAL INSTITUTIONS.	Number examined.	Number registered.	Year of Graduation of Rejected Applicants.
Hahnemann, Chicago,	1	1	
Indiana University,	1	-	1910.
University of North Carolina,	1	-	1910.
Kentucky University,	1	-	1904.
Medico-Chirurgical, Baltimore,	1	-	1909.
American School of Osteopathy,	1	-	1910.
University of Michigan,	1	1	
Northwestern University,	1	1	

Tabulation showing number of first examinations and average ratings of graduates from medical schools represented by not less than three applicants: —

MEDICAL INSTITUTIONS.	Number examined.	Average Rating.
Tufts,	69	76.2
Harvard,	44	78.7
Physicians and Surgeons, Boston,	23	65.7
Massachusetts College of Osteopathy,	19	71.2
Boston University,	13	78.8
Dartmouth,	10	77.8
Foreign,	10	71.8
Baltimore Medical,	6	77.7
University of Maryland,	6	75.6
Maryland Medical,	5	70.9
Medical School of Maine,	5	75.1
McGill,	4	84.3
University of Pennsylvania,	4	80.3
University of Vermont,	3	76.9
Laval,	3	54.7
Physicians and Surgeons, New York,	3	80.0
Johns Hopkins,	3	79.2

Application for examination must be made upon blanks furnished by the Board and presented not later than five days before the date of examination.

A ticket of admission to an examination, showing examination date and the applicant's number, is issued on receipt of application; also to rejected applicants entitled to a re-examination, if applied for on or before the five days next preceding an examination.

The three examinations in a year, provided by law, begin respectively on the second Tuesday in March, July and November. Special meetings for conducting examinations may be held beginning on the second Tuesday in May and in September.

The time devoted to each examination is three days. The questions are grouped in seven sets, of ten questions in each set; the answers are rated on a scale of 0 to 100. When general averages fall below 75 percentum, examinations are classed as unsatisfactory.

The examinations are conducted in the English language only.

The questions are intended to be practical, and to cover substantially the instruction given in the high-grade medical schools in this country. The subjects on which the examinations are principally conducted are anatomy and histology, physiology and hygiene, pathology and bacteriology, surgery, obstetrics and gynecology, diagnosis and therapeutics, and pediatrics and toxicology.

Applicants who furnish satisfactory evidence of having conducted a reputable practice for fifteen years or more are frequently admitted to an examination largely oral. In the opinion of the Board, an examination so conducted for such practitioners is best adapted to meet the requirements of the law.

The law requires that the "examinations shall be wholly or in part in writing." It should be noticed that this requirement does not preclude oral examinations in part, nor in part practical work in the laboratory, or other demonstrations of a practical character.

Since the organization of this department, in July, 1894, the Board has issued 8,978 certificates of registration. Of this number, 3,792 were issued prior to January, 1895, during the six months following the organization of the Board, to physicians practising in the Commonwealth at the time the registration act became in part operative. There were 608 persons refused registration during the six months above referred to, they being unable to meet the requirements of the law as to graduation, or as to three years of continuous practice in the Commonwealth next prior to the passage of the law.

The work of registration under written examinations, conducted by the Board as required by law, began with the year 1895. Since that time the Board has given 7,281 individual examinations and has issued 5,181 certificates of registration, — an annual average of 324. The number of unsatisfactory examinations during this period is 2,096, — an annual average of 131.

The number of names now in the card catalogue of physicians living is approximately 7,900. The difference between the number of names in the catalogue and the number of certificates of registration issued represents the number (1,078) of registered persons who have died since the organization of the Board. It should not be understood, however, that the names in the catalogue represent definitely the number of practitioners in the Commonwealth at the present time. Many have settled in other States. The approximate number of physicians practising in this Commonwealth is 6,000, — a ratio of about 1 to 500 of the inhabitants.

List of the Names of Applicants registered in 1910.

Allen, Horace Parkhurst.
Almy, Thomas.
Arthur, Eleanor Mary.
Arthur, James B McKee.
Averill, Edna Blanche.
Azadian, David George.

Babcock, Harold Lester.
Bailey, Charles Hervey.
Bailey, Karl Roland.
Baker, Chester Stoyle.
Balcom, Kenneth Ira.
Bodwell, William Mortimer.
Bolduc, Alfred George.
Bond, Earl Danforth.
Boyden, Arthur Henry.
Brace, Edward Alfred.
Bresnahan, John Francis.
Brooks, Howard Daniel.
Brown, Joseph.
Bryant, John.
Burnett, Louis Raymond.
Burns, Mary Elizabeth.
Burns, Newell Bly.
Burrier, Walter.
Byrne, Claudius James.

Cameron, Edward Spence.
Carroll, Michael James.
Claffy, John McMahon.
Clark, Harry Ainsworth.
Clarke, Harry Carver.
Clarke, Oliver Holman.
Cochrane, Philip Sydney.
Cody, Harry Clinton.
Coffin, Susan May.
Collins, Joseph Daniel.
Connell, Thomas Michael.
Connor, George James.
Conway, William Stanislaus.
Cook, James Henry.
Cook, William Wilder.
Cooper, James Fryer.
Corcoran, George Bartlett.
Coughlin, Frederick Aloysius.
Coughlin, John Francis.
Cowan, Clyde Robert.
Cox, Stanley Cullen.
Crandall, Walter Midkiff.
Cummings, Dana Frank.
Cunningham, Thomas Edward, Jr.
Curran, George Lally.
Cutler, George David.

List of the Names of Applicants registered in 1910 — Continued.

Davidson, Alfred.
DeSevo, Guiseppe.
Dixon, Arthur.
Dodd, John Edward.
Dodge, Ralph Oscar.
Donovan, Walter James.
Dow, Frank Edward.
Ducharme, Alphonse Napoleon.
Dunn, James Ringer.

Estey, Clarence Wallace.

Fairchild, Ann.
Fay, Joseph Henry.
Felt, Paul Revere.
Findeisen, William Ernest.
Fishman, Maurice.
Fletcher, Arthur Stanton.
Flint, George Calvin.
Flynn, Timothy John.
Foster, Alfred Edward.
French, Katharine.
French, Ralph Winward.
Frost, Henry Pinckney.
Funnell, Wilfred Golden.

Gamble, James Lauder.
Gerber, Isaac.
Goodall, Edwin Baker.
Gove, John McClure.
Grady, James Edward.
Granstein, Charles Israel.
Grasso, Antonio.
Groelund, Wilho Arvid.

Hagerty, Harry John.
Haigh, Gilbert William.
Haley, Paul James Dodge.
Hamilton, Burton Everett.
Harrington, Daniel James Leo.
Hassett, Leonard Watson.
Heffernan, Dennis William.
Hegarty, Joseph Gordon.
Hepburn, James Joseph.
Hersey, Harold Waters.
Howard, Arthur Allison.
Hunt, Harold Otis.

Jacques, Hector.
Johnson, Herbert Lewis.
Jones, Robert LeRoy.
Judkins, Charles Louville Mason.

Kagan, Samuel Henry.
Kellogg, Foster Standish.
Kerr, Robert Brown.
Kilburne, Ira Nelson.
King, George Clifford.
Knowlton, Edward Allen.
Knudson, Mette Marie.
Kohr, Thomas William.

La Fortune, Wilfrid Teller.
Lake, LaFayette.
Lamoureux, Stanislaus Albert.
Leonard, Ralph Davis.
Loder, Halsey Beach.
Looney, Edward Michael.
Loredo, Serafin.
Lougee, George Woodworth.

McCarthy, Eugene Francis.
McCarty, James Joseph, Jr.
McCluskey, Richard John.
McGinity, Joseph Taney.
McGuire, George Alexander.
McRae, Alexander John.
MacLean, Donald John.
Mahoney, Matthew Patrick.
Marble, Henry Chase.
Marston, Warren Winfield.
Martin, Arthur Chalmers.
Mason, Broadstreet Henry.
Mathews, Frank Harrison.
Matthews, Thomas Andrew.
Mayo, Thomas Franklin.
Miller, Richard Henry.
Mitsakos, Demetrios Anagnos.
Monjardino, Jorge Almeida.
Moore, Fredrika.
Muir, Robert Joseph.
Mulvainty, Sadie Angula.
Murphy, John Patrick Henry.
Murray, Benjamin Frank.
Myers, Edward Louis.

Nicholls, Melvin Henry.
Nicholson, Harry Manley.
Noonan, William Andrew.
Noyes, Arthur Percy.

O'Keeffe, James Vincent.
Olin, Harry.
O'Rourke, Edward James.
Osgood, Gardner Holway.
O'Sullivan, Anna.
Overlander, John Eliot.

Palmer, Walter Walker.
Parcher, George.
Parker, Mary.
Parlin, Ralph Brown.
Partridge, Carroll Dunham.
Payzant, Claude Louis.
Penny, Mary McDermott.
Pfefferkorn, Otto Albert.
Phelan, Edward Francis.
Phillips, Charles Lewis.

List of the Names of Applicants registered in 1910 — Concluded.

Pillsbury, Fitzroy Farnsworth.
Piper, John Obed.
Polsey, Emma Adrienne.
Porter, Charles Hunt, Jr.
Powers, John Thomas Haliburton.
Proctor, Grover Cleveland.

Richards, Ernest Thompson Fraser.
Richardson, William Enville.
Robertson, Ewan Alexander.
Roddy, Martin Bernard.
Roney, Hugh Beverly.
Rosen, David William.
Ryder, Charles Tripp.

Sawaya, George Elias.
Schadt, George Leonard.
Schillander, Carl Axel.
Sheppard, Philip Albert Edward.
Slater, Eleanor Mary.
Smith, Earl Moulton.
Smith, Harold Heber.
Sparrow, Charles Asatt.
Starr, Samuel.
Stearns, Albert Warren.
Swift, John Baker, Jr.
Symonds, Mary Dean.

Taylor, Maude Winnifred.
Thomas, Elmer Ellsworth.
Thore, Christopher Davis.
Toomey, Joseph Humphrey.
Torrey, Arthur Stanley.
Trull, Alfred Chase.
Tynan, Joseph Patrick.

Underwood, Gordon Brooks.
Uniac, Thomas Vincent.

VanDyne, Oliver.
Van Riempst, Theodore Servais Eugene Schalpkens.
Veazie, Albert Valentine.
Vincent, Eugene Todhunter.
Von Gerber, Wilhelmina Georgina Marie.
Vosburgh, Stephen Earle.
Vreeland, John Albert.

Wallace, Harold Lowe.
Wallace, Wilford Hall.
Walsh, Daniel Joseph.
Walsh, Edmund Francis.
Walsh, James Henry.
Walsh, James Joseph.
Watson, Helen.
Webb, Albert Edward.
Weinert, Ernest.
Weller, John Henry.
Whitcomb, Charles Sumner Fremont.
White, Robert Marshall.
Wilde, Salmon Perry.
Wilson, Edmund Winfred.
Wilson, Henry Delano.

The Appendix contains the law relating to registration, and opinions of courts and of the Attorney-General.

Respectfully submitted,

SAMUEL H. CALDERWOOD, *Chairman.*
EDWIN B. HARVEY, *Secretary.*
WALTER P. BOWERS.
AUGUSTUS L. CHASE.
CHARLES H. COOK.
MATTHEW T. MAYES.
NATHANIEL R. PERKINS.

APPENDIX.

APPENDIX.

LAW RELATING TO THE REGISTRATION OF PHYSICIANS.

[REVISED LAWS, CHAPTER 76, SECTIONS 1–9.]

SECTION 1. There shall be a board of registration in medicine consisting of seven persons, residents of this commonwealth, who shall be graduates of a legally chartered medical college or university having the power to confer degrees in medicine, and who shall have been for ten years actively employed in the practice of their profession. No member of said board shall belong to the faculty of any medical college or university, and no more than three members thereof shall at one time be members of any one chartered state medical society. One member thereof shall annually in June be appointed by the governor, with the advice and consent of the council, for a term of seven years from the first day of July following.

SECTION 2. Said board shall hold regular meetings on the second Tuesday of March, July and November in each year, and additional meetings at such times and places as it may determine. At the regular meeting in July, it shall organize by the choice of a chairman and secretary who shall hold their offices for the term of one year. The secretary shall give a bond to the treasurer and receiver general in the penal sum of five thousand dollars, with sufficient sureties to be approved by the governor and council, for the faithful performance of his official duties.

SECTION 3. Applications for registration shall be made upon blanks to be furnished by the board, and shall be signed and sworn to by the applicants. Each applicant for registration shall furnish satisfactory proof that he is twenty-one years of age or over and of good moral character and, upon payment of a fee of twenty dollars, shall be examined by said board. If he is found by four or more members thereof to be twenty-one years of age or over, of good moral character and qualified, he shall be registered as a qualified physician and shall receive a certificate thereof signed by the chairman and secretary. An applicant who fails to pass an examination satisfactory to the board, and is therefore refused registration, shall be entitled within one year after such refusal to a re-examination at a meeting of the board called for the examination of applicants, without the payment of an additional fee; but two such re-examinations shall exhaust his privilege under his original application. Said board, after hearing, may by unanimous vote revoke any certificate issued by it and cancel the registration of any physician who has been convicted of a felony or of any crime in the practice of his profession. All fees received by the board shall, once in each month, be paid by its secretary into the treasury of the commonwealth.

[SECTION 4.[1] Each member of the board shall receive ten dollars for every day actually spent in the performance of his duties, and the necessary travelling expenses actually expended in attending the meetings of the board, not exceeding three cents a mile each way. Such compensation and the incidental and travelling expenses shall be approved by the board and paid by the commonwealth only from the fees paid over by the board.]

SECTION 5. The board shall keep a record of the names of all persons registered hereunder, and of all money received and disbursed by it, and a duplicate thereof shall be open to inspection in the office of the secretary of the commonwealth. Said board shall annually, on or before the first day of January, make a report to the governor of the condition of medicine and surgery in this commonwealth, of all its official acts during the preceding year and of its receipts and disbursements.

SECTION 6. The board shall investigate all complaints of the violation of the provisions of section eight, and report the same to the proper prosecuting officers.

SECTION 7. Examinations shall be wholly or in part in writing in the English language, and shall be of a scientific and practical character. They shall include the subjects of anatomy, surgery, physiology, pathology, obstetrics, gynecology, practice of medicine and hygiene, and shall be sufficiently thorough to test the applicant's fitness to practise medicine.

SECTION 8. Whoever, not being lawfully authorized to practise medicine within this commonwealth and registered as aforesaid, holds himself out as a practitioner of medicine, or practises or attempts to practise medicine in any of its branches, or whoever practises medicine or surgery under a false or assumed name, or under a name other than that by which he is registered, or whoever personates another practitioner of a like or different name, shall, for each offence, be punished by a fine of not less than one hundred nor more than five hundred dollars, or by imprisonment for three months, or by both such fine and imprisonment. In a case in which a provision of this or the preceding section has been violated, the person who committed the violation shall not recover compensation for services rendered.

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[1] **Repealed by the Acts of 1902, and fixed salaries established.**

SECTION 9. The provisions of the eight preceding sections shall not be held to discriminate against any particular school or system of medicine, to prohibit medical or surgical service in a case of emergency, or to prohibit the domestic administration of family remedies. They shall not apply to a commissioned medical officer of the United States army, navy or marine hospital service in the performance of his official duty; to a physician or surgeon from another state who is a legal practitioner in the state in which he resides, when in actual consultation with a legal practitioner of this commonwealth; to a physician or surgeon residing in another state and legally qualified to practise therein, whose general practice extends into the border towns of this commonwealth, if such physician does not open an office or designate a place in such towns where he may meet patients or receive calls; to a physician authorized to practise medicine in another state, when he is called as the family physician to attend a person temporarily abiding in this commonwealth; nor to registered pharmacists in prescribing gratuitously, [osteopathists,[1]] pharmacists, clairvoyants, or persons practising hypnotism, magnetic healing, mind cure, massage, Christian science or cosmopathic method of healing, if they do not violate any of the provisions of section eight.

COMMONWEALTH *v.* ST. PIERRE.

This is a case in which a person in Fall River was accused of practising medicine without registration. His professional sign was that of an "eye specialist." He was sentenced in the municipal court to three months' imprisonment and to pay a fine of five hundred dollars, the maximum penalty. The case was carried to the superior court, where sentence was sustained; but certain exceptions were taken by the defendant's counsel to the rulings of the court. The exceptions were finally disposed of in the following opinion of the supreme judicial court, rendered on the thirteenth day of December, 1899: —

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[1] Repealed by chapter 526, Acts of 1909.

LORING, J. The exception to the exclusion of testimony offered by the defendant on cross-examination must be sustained. The government had introduced in evidence testimony of a number of persons to the effect that they had visited the defendant at various times; that he gave to them medicines, and advised them how to use them; that at these times they had conversations with him about the nature of their complaints; that he afterwards visited some of them at their houses and treated them there, and that they paid him money; and the bottles and packages, which the witnesses testified were given to them, had been put in evidence.

The defendant offered to prove that "each and every occasion at the time the parties were told by the defendant that he was not a doctor, and that he did not charge anything for his services." This evidence was excluded.

If the defendant sold the medicines, receiving payment therefor, and gave advice gratuitously as to the use to be made of them, he was not, so far as those instances were concerned, holding himself out as a physician; his declarations accompanying the acts and showing the character of them were admissible as part of the *res gestæ.*

Of course it was open to the government to contend that in these instances he was really acting as a physician, and was paid as such for his services, and that these statements were efforts to evade the statutory provisions here in question.

But when the Commonwealth put in testimony to the effect that he had given directions and advice as to the use of the contents of the packages and bottles sold by him, and had been paid by the persons to whom the contents were sold, it was the right of the defendant to prove that in each instance he was paid not for the advice but only for the drugs, and that he declared that he was not a physician; and in that way to raise the question whether, so far as these instances were concerned, he was selling the drugs and giving information gratuitously as to their use, and therefore not thereby holding himself out as a physician, or whether he was really acting as a physician, taking payment therefor, and was seeking by such declarations to evade the effect of his actions. This question was a question for the jury, under all circumstances, and the testimony offered should have been admitted.

As the questions involved in the other exceptions may arise in a new trial, they may be briefly disposed of here: —

2. The burden was on the defendant to show that he was a registered physician, if he relied on such a justification. (Pub. Sts., c. 214, § 12.) This applies to cases where the absence of a license is made part of a description of the offence. (Commonwealth *v.* Kelly, 10 Cush. 69; Commonwealth *v.* Tuttle, 12 Cush. 502; Commonwealth *v.* Barnes, 138 Mass. 152; Commonwealth *v.* McCarthy, 141 Mass. 420.)

3. Proof that the defendant acted either as a physician or surgeon was sufficient to support the complaint, which charged him with holding himself out as a physician and surgeon. There is but one offence, and

that may be committed by the defendant's holding himself out as a physician or a surgeon; if the complaint charges that the offence is committed by the defendant's holding himself out both as a physician and surgeon, the whole offence is proved if he is shown to have held himself out as either. (Commonwealth *v.* Dolan, 121 Mass. 374.)

4. The ruling that, if the defendant held himself out as an eye specialist, he held himself out as "one who devoted himself to a branch of the healing art which is the profession of the physician and surgeon," and that "if the defendant held himself out as an eye specialist, he held himself out as a physician and surgeon within the meaning of the statute," was correct.

New trial ordered.

COMMONWEALTH *v.* MADDALINA DELLA-RUSSO.

The complaint against Della-Russo, a midwife, was that she held herself out as a practitioner of medicine; and that she practised medicine unlawfully. In the lower court, Suffolk County, William J. Forsaith, justice, she was adjudged guilty on both counts. An appeal was taken and the case was tried in the superior court, December term, 1904. Verdict, guilty on both counts. The contention of the defendant's counsel was that in holding herself out as a midwife she did not hold herself out as a practitioner of medicine, and that in her practice she attended only normal cases of labor, and in so doing she acted in the capacity of a nurse only.

Robert O. Harris, justice, charged the jury as follows: —

In the consideration of this case, it is well for the jury in the beginning to start upon their deliberations with a well-defined idea of what the issue is. This complaint charges the defendant in two counts; first, with holding herself out as a practitioner of medicine; second, as having practised medicine. The statute under which we are proceeding provides that, "Whoever, not being lawfully authorized to practise medicine within this commonwealth and registered as aforesaid, holds himself out as a practitioner of medicine, or practises or attempts to practise medicine in any of its branches," shall be subject to a certain penalty. This statute, enacted in 1894, may be said to be a re-enactment, in a little different shape and with wider scope, of laws which have been on the statute books of this commonwealth for many years. Under the old law there arose the question which has been raised in this case, as to whether it is necessary that a person should hold himself out to practise medicine generally in order to come within the purport of the statute. Under the early statute, in 1835, Chief Justice Shaw of the supreme court rendered an opinion as follows: —

> The first question for the court is whether, upon the facts agreed, the defendant can be held to be engaged in the practice of physic or surgery. It appears that he

> professes and practises bone setting and reducing sprains, swellings and contractions of the sinews, by friction and fomentations; but no other department of the curing art. By bone setting we understand the relief afforded as well in cases of dislocation as in those of fracture. The court are of the opinion that this brings him within the meaning of the statute as one who practises physic or surgery. We think it not necessary for one to profess to practise generally, either as a physician or surgeon, to bring him within the operation of this statute, but that it extends to any one engaging in practice in a distinct department of either profession, and that the defendant's practice forms a considerable department in the practice of surgery.[1]

That is to say, if one holds himself out to practise or practises in any line of endeavor which comes within the territory which belongs to medicine, he comes under this act, although he may follow a specialty.

But this precise question as to whether midwifery is included within the statute has been directly decided in another Commonwealth, under a statute very similar in terms to ours. The case was a complaint against a woman for practising midwifery. The supreme court of that State said: —

> It appeared from the proof that the defendant held herself out as a midwife and practised in that capacity. It is urged this is not a violation of the act. We think very clearly it is. Midwifery is an important department of medicine, and is so recognized by the act. The law-making power of the State has enacted that "No person shall practise medicine in any of its departments in this State without the qualifications required by this act." The validity of such a law is not denied, but it is urged only that the defendant had not practised medicine within the meaning of the act. It needs no argument to show the importance of obstetrics as a department of medicine, nor the necessity that those who assume to practise in that department should possess due knowledge and skill. The welfare of their patients is certainly within the purview of the law, no less than in other departments, where, in many instances, at least, even less care and skill may be essential, and where the consequence of ignorance and unskillfulness may be less unfortunate.[2]

Under the rulings in these cases to which I have referred, and under the law as I understand it, I shall have to instruct you that as a matter of law one who undertakes to practise midwifery is one who is undertaking to practise medicine. The issue in this case is, therefore, whether this defendant has undertaken to practise as midwife. If so, she is within the language of the act, because she has undertaken to practise medicine, or a branch thereof.

The question, then, in this case narrows itself down to just what this defendant did. She claims that she did not hold herself out to practise in any other way than as a mere nurse; and that she assumed no responsibilities in anything that she did in any case other than those of an ordinary trained or skilled nurse. And upon that issue you have to consider the evidence in the case. If all she did was to act simply as a nurse, acting under somebody else's directions, and doing only those things which a mere nurse ordinarily does, and assuming no responsibility for anything excepting that she should do the things well as a nurse, then she is not guilty under this complaint. If, however, while calling herself a nurse she actually assumed the function of a physician, and advertised herself as being competent to perform the duties of an ordinary physician, and was engaged upon that understanding, then you will be warranted in finding her guilty.

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[1] Hewett v. Charier, 16 Pickering, 353.

[2] People v. Arendt, 60 Ill. App. 98.

OPINION OF THE ATTORNEY-GENERAL RELATIVE TO THE EXAMINATION OF APPLICANTS UNABLE TO WRITE IN ENGLISH.

OFFICE OF THE ATTORNEY-GENERAL, BOSTON, Feb. 13, 1906.

EDWIN B. HARVEY, M.D., *Secretary, Board of Registration in Medicine.*

DEAR SIR: — I beg to acknowledge the receipt of your favor of the 9th. Your Board requests the opinion of the Attorney-General as to the legality of conducting examinations of applicants for registration in other than the English language, provided that the applicant offers to pay for the services of a translator to translate his written papers into English.

Revised Laws, chapter 76, section 7, provides that —

> Examinations shall be wholly or in part in writing in the English language, shall be of a scientific and practical character, shall include the subjects of anatomy, surgery, physiology, pathology, obstetrics, gynecology, practice of medicine and hygiene, and shall be sufficiently thorough to test the applicant's fitness to practise medicine.

The question raised is, whether an examination in writing in some language other than English, the examination papers being translated by an interpreter at the expense of the applicant, is in compliance with the requirements of this statute.

The Legislature evidently intended that all persons permitted to practise medicine in this Commonwealth should have some knowledge of the English language. An examination in writing in the English language is, therefore, a test of the general qualifications of the applicant, as distinguished from his strictly technical qualifications. The statutes contemplate that each applicant shall show both general and technical qualifications. Whether or not a person who is unable to write English ought to be permitted to practise medicine in this Commonwealth, where English is the language commonly employed, is not for me to determine. It is clear, however, that there are many reasons which make it desirable that a person practising medicine should have some familiarity with English, and that a requirement of some knowledge of that language is not unreasonable. The natural meaning of the statute is that papers shall be written in English, and no reason appears why the construction should be strained to give the words some other meaning. If this interpretation seems to work hardship, it may be noted that the Board has considerable discretion as to how large a part of the examination shall be in writing.

I am of the opinion that examinations must be, at least in part, in writing in the English language, not only when they come to the attention of the examining Board, but even when they leave the hands of the persons examined. I am therefore of the opinion that the suggested procedure is not permissible.

Very truly yours, DANA MALONE,
Attorney-General.

OPINION OF ATTORNEY-GENERAL RELATIVE TO THE PROPER INTERPRETATION OF CERTAIN PROVISIONS OF THE LAW.

OFFICE OF THE ATTORNEY-GENERAL, BOSTON, Dec. 18, 1907.

EDWIN B. HARVEY, M.D., *Secretary, Board of Registration in Medicine.*

DEAR SIR: — The Board of Registration in Medicine desires my opinion "as to the intent or meaning of the latter part of section 9, chapter 76 of the Revised Laws, beginning with the word ***nor*** in the seventeenth line."

The section above referred to provides as follows: —

> The provisions of the eight preceding sections shall not be held to discriminate against any particular school or system of medicine, to prohibit medical or surgical service in a case of emergency, or to prohibit the domestic administration of family remedies. They shall not apply to a commissioned medical officer of the United States army, navy or marine hospital service in the performance of his official duty, . . . nor to registered pharmacists in prescribing gratuitously, osteopathists, pharmacists, clairvoyants, or persons practising hypnotism, magnetic healing, mind cure, massage, Christian science or cosmopathic method of healing, if they do not violate any of the provisions of section eight.

Section 8 provides that —

> Whoever, not being lawfully authorized to practise medicine within this commonwealth and registered as aforesaid, holds himself out as a practitioner of medicine, or practises or attempts to practise medicine in any of its branches, or whoever practises medicine or surgery under

a false or assumed name, or under a name other than that by which he is registered, or whoever personates another practitioner of a like or different name, shall, for each offence, be punished by a fine of not less than one hundred nor more than five hundred dollars, or by imprisonment for three months, or by both such fine and imprisonment. In a case in which a provision of this or the preceding section has been violated, the person who committed the violation shall not recover compensation for services rendered.

The preceding seven sections provide for the establishment of a Board of Registration in Medicine (section 1), for its meetings and organization (section 2), and for the examination and registration of physicians and surgeons (sections 3–7).

I am of the opinion that the meaning of the clause of section 9 to which the inquiry of the Board is directed is that an osteopathist may practise osteopathy so long as he does not hold himself out as a practitioner of medicine, or does not practise or attempt to practise medicine in any of its branches, or does not violate any of the other penal provisions of section 8.

The Board further inquires: —

Should an osteopathist, so called, or a hypnotist display to public view a business sign whereon he designates himself Dr., or Doctor, or Physician, or makes use of these or any other title in a manner, or under such conditions or circumstances, or in such connection that it may serve as an announcement or indication of a readiness to engage in the practice of treating diseases of the human body, would he be justly liable to prosecution and conviction under the provisions of section 8 of the said chapter?

This inquiry raises a question of fact rather than of law. If the sign or title is such as to lead the public to believe the osteopathist or hypnotist to be a practitioner of medicine, it would be a violation of section 8 and therefore would not be sanctioned by section 9. The question is in each case whether the acts of the practitioner or osteopathist are sufficient to constitute holding such person out as a practitioner of medicine, and this is a pure question of fact, to be determined upon the evidence obtainable in such case.

Very truly yours, DANA MALONE,
Attorney-General.

COMMONWEALTH *v.* PORN.

This is a case in which a midwife in Gardner was accused of practising medicine without registration. In the municipal court she was found guilty and sentenced to pay a fine of one hundred dollars. In the superior court she was also found guilty, but exceptions to the rulings of Judge Aiken, before whom the case was tried, were allowed, which, in October, 1907, were heard by the supreme court and overruled. The opinion handed down by Mr. Justice Rugg is as follows: —

This is a complaint charging that the defendant "did practise medicine" and did "hold herself out as a practitioner of medicine" contrary to Revised Laws, chapter 76, section 8.

After the case was first heard by us (see Mass. Reports, vol. 194) the defendant was again tried in the superior court upon an agreed statement of facts, the substance of which was that at the time mentioned in the complaint, and for some years prior, the defendant held herself out as a midwife and practised midwifery, but did not claim to be a general practitioner of medicine, nor was she lawfully authorized to practise medicine as provided by Revised Laws, chapter 76, section 3. She delivered many women in childbirth for compensation, and carried with her to patients the usual obstetrical instruments, which she used rarely on occasions of emergency, but never if a physician could be called in time. She used six printed prescriptions or formulas in treating her patients, which contained directions for their application, and the purposes for which they were used, as follows: "For vaginal douche," "for post-partum hemorrhage," "to prevent purulent ophthalmia in the new-born," "for after-pains," "for uterine inertia" and "for painful hemorrhoids or piles." She used no other prescriptions or formulas. She was a trained nurse of experience and was a graduate of the Chicago Midwife Institute, from which she received a diploma which stated that she had received theoretical and practical instruction in the art of midwifery for a period of six months, and was declared a graduated midwife. Upon these facts the superior court ruled that the jury would be authorized to find the defendant guilty, and the defendant's first exception relates to this ruling. When the facts are undisputed, it is generally a question of law whether they constitute a violation of the statute. (Commonwealth *v.* Porn, 194 Mass.)

Both medical and popular lexicographers define midwife as a female obstetrician, and midwifery as the practice of obstetrics.

Revised Laws, chapter 76, section 7, mentions obstetrics as one of the subjects of examination for the purpose of testing an applicant's fitness to "practise medicine." This goes far toward showing that obstetrics is a branch of the practice of medicine. It requires no discussion to demonstrate that, when in addition to ordinary assistance in the normal cases of childbirth there is the occasional use of obstetrical instruments, and a habit of prescribing for the conditions described in the printed formulas which the defendant carried, such a course of conduct constitutes the practice of medicine in one of its branches. Although childbirth is not a disease, but a normal function of women, yet the practice of medicine does not appertain exclusively to disease, and obstetrics, as a matter of common knowledge, has long been treated as a highly important branch of the science of medicine. In Higgins *v.* McCabe, 126 Mass., it is intimated that treatment of eyes of the infant (for which one of the prescriptions of the defendant was employed) is not within the duties of midwifery. In view of all the agreed facts, there was no error in submitting the case to the jury.

The defendant also offered expert evidence to prove that the practice of the defendant, as shown in the agreed facts, was not the practice of medicine in any of its branches, and that the conduct of the defendant was not holding herself out as a practitioner of medicine. This offer of evidence was excluded, against the objection and exception of the defendant.

The former decision of this case said that expert medical evidence was admissible to prove " what a midwife does or is expected to do as such, so that the court may see whether her acts or any of them are regarded as the practice of medicine in any of its branches. . . . Whether upon such evidence it would appear that the ministrations of a midwife are those of a physician, or rather of an attendant nurse and helper, would ordinarily be a question of fact, or, if the facts were not in dispute, a question of law." (194 Mass.) At the present trial the facts were agreed. All that the defendant sought to show was that these facts in the opinion of experts did not constitute the practice of medicine. But as the facts were not in dispute, within the former decision, the question was not one for expert evidence but for the court. Moreover, on all the facts shown as to the use of prescriptions and the pains they were stated to alleviate, and the use of obstetrical instruments, as well as attendance and service at childbirth by the defendant, it would be contrary to the plain intent of the statute and flying in the face of the common use of words to permit experts to testify that the language employed in the statute did not comprehend the acts confessedly performed by the defendant. We are far from saying that it would not be within the power of the Legislature to separate, by a line of statutory demarcation, the work of the midwife from that of the practitioner of medicine. The statute now under consideration does not make such separation. Whatever hardship there may be upon the defendant, who is a woman of good character and reputation, as shown by the agreed facts, comes from the scope of the statute.

The defendant contends that the statute as thus construed is unconstitutional. Its validity cannot be questioned on this ground. The maintenance of a high standard of professional qualifications for physicians is of vital concern to the public health, and reasonable regulations to this end do not contravene any provision of the State or Federal Constitution.

Exceptions overruled.

COMMONWEALTH *v.* JEWELLE.

This is a case of a proprietor of a so-called sanitarium in Springfield, who was accused of practising medicine without registration. The defendant was convicted in the municipal court, and again in the superior court held by Judge Crosby. The exceptions to the rulings of the court were disposed of in an opinion of the supreme court, as follows: —

HAMPDEN. OCT. 19, 1908.

Illegal Practice of Medicine — Revised Laws, Chapter 76, Section 8 — Evidence.

Complaint charging a violation of the Revised Laws, chapter 76, section 8, by practising medicine without being authorized so to do. In the superior court, before Crosby, J., there was a verdict of guilty, and defendant excepted.

S. S. Taft for Commonwealth.

R. J. Talbot for defendant.

KNOWLTON, C.J. — The defendant was convicted under a complaint charging him with a violation of the Revised Laws, chapter 76, section 8, by practising medicine in this Commonwealth without being lawfully authorized so to do. There was conflicting evidence at the trial in regard to what he had done. To quote from the judge's charge: "The Commonwealth says also that upon different occasions the defendant has prescribed medicines and administered, and advertised that he prescribed as a part of his treatment, what he called 'vitalizer,' and that he has been in the habit of giving what are called electric or ray baths, and that on one or more occasions, in the giving of what was called the stomach wash, another substance than water was in the tumbler, which was taken by the patient." There was also evidence that on different occasions he "did make a diagnosis of the patients, for the purpose of ascertaining what ailed them, and that then he prescribed for them treatment which was afterward administered to them." The defendant did not admit this. In his charge the judge said: "The defendant does not claim that he has any knowledge of drugs or of disease in the ordinary sense in which that word is used. I understand him to testify that he did not understand about diseases, that he did not treat disease, but that he treated the healthy portion of the body."

The defendant asked the court to rule that "There is no law against a person being a mind cure healer, or a massage healer, or an osteopathist; he can practise his healing so long as he did not prescribe or deal out medicine." The defendant excepted to the refusal of the judge to give in terms the last part of this request. He also excepted to the "rulings and refusals to rule."

This exception cannot avail the defendant to open objections to the charge as a whole, or to statements in the charge on matters to which the judge's attention was not called by the defendant. (Curry *v.* Porter, 125 Mass. 94; Com. *v.* Meserve, 154 Mass. 64–65.) Under the decision in Brick *v.* Bosworth, 162 Mass. 334, nothing more than the refusal of the request and the rulings given upon the specific matters to which attention was called by the request is opened by such an exception.

The first part of the request was plainly covered by the judge's charge. As to the last clause of the request, the charge was, in substance, that such a person can practise his healing or treatment in either of these ways so long as he does not go beyond the practice or treatment that is fairly included in such of these methods as he adopts, and practise medicine within the meaning of the Revised Laws, chapter 76, section 8, otherwise than by using one or more of these methods. The defendant's request implied that one could not practise medicine within the meaning of the words in section 8 without prescribing or dealing out medicine, that is, prescribing or dealing out a substance used as a remedy for disease. The judge allowed the jury to find that one might practise medicine within the meaning of the statute, that is, might practise the healing art, or the art or science which relates to the prevention, cure or alleviation of disease, without necessarily prescribing or dealing out a substance to be used as a medicine. In this we think he was right. It would be too narrow a view of the practice of medicine to say that it could not be engaged in in any case or class of cases otherwise than by prescribing or dealing out a substance to be used as a remedy. The science of medicine, that is, the science which relates to the prevention, cure or alleviation of disease, covers a broad field, and is not limited to that department of knowledge which relates to the administration of medicinal substances. It includes a knowledge not only of the functions of the organs of the human body, but also of the diseases to which these organs are subject, and of the laws of health and the modes of living which tend to avert or overcome disease, as well as of the specific methods of treatment that are most effective in promoting cures. It is conceivable that one may practise medicine to some extent, in certain classes of cases, without dealing out or prescribing drugs or other substances to be used as medicines. It is conceivable that one may do it in other ways than those practised as a part of their respective systems, by either "osteopathists, pharmacists, clairvoyants, or persons practising hypnotism, magnetic healing, mind cure, massage, Christian science or cosmopathic method of healing."

The purpose of the statute seems to be to permit the practice of these several methods of treatment, including everything that strictly belongs to each, but not to permit the unlicensed practice of medicine otherwise. If a practice of medicine otherwise, without dealing out or prescribing drugs or other substances to be used as medicine, is possible, the rulings and refusals to rule were right. We think such a practice of medicine is possible.

There is nothing in the bill of exceptions, except the statements in the judge's charge, to show what the facts were upon which the Commonwealth relied. There were no other requests for instructions as to what would constitute the practice of medicine, and there is nothing to show that more specific instructions were necessary. Much less is there any exception to the failure to instruct more particularly as to what would constitute the practice of medicine.

There is much to indicate that the defendant not only practised medicine in other ways, but that he dealt out substances to be used as medicines, which did not apply to the practice of osteopathy, mind cure or massage. These exceptions must be overruled.

The defendant also excepted to the refusal of the court to grant his motion to dismiss the complaint, on the ground that the statute is unconstitutional. The question thus raised was decided against the defendant's contention in Com. *v.* Porn, 196 Mass. 326.

Exceptions overruled.

Public Document **No. 38**

TWENTY-FOURTH ANNUAL REPORT

OF THE

MASSACHUSETTS BOARD OF REGISTRATION IN DENTISTRY.

FOR THE YEAR 1910.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1911.

APPROVED BY
THE STATE BOARD OF PUBLICATION.

MEMBERS

OF THE

MASSACHUSETTS BOARD OF REGISTRATION IN DENTISTRY.

1910.

JOHN F. DOWSLEY, D.D.S., *President,*	Boston.
GEORGE E. MITCHELL, D.D.S., *Secretary,*	Haverhill.
THOMAS J. BARRETT, D.D.S.,	Worcester.
GEORGE A. MAXFIELD, D.D.S.	Holyoke.
WILLIAM W. MARVEL, D.M.D.,	Fall River.

The Commonwealth of Massachusetts.

To His Excellency EUGENE N. FOSS, *Governor*.

SIR: — Complying with the provision of section 26, chapter 76 of the Revised Laws, the State Board of Registration in Dentistry has the honor to submit the following, its twenty-fourth annual report, for the year ending Dec. 31, 1910.

The commissions of George A. Maxfield, D.D.S., of Holyoke, and William W. Marvel, D.M.D., of Fall River, having expired, they were reappointed as members of this Board for three years, and qualified according to law.

The former organization of the Board was continued, John F. Dowsley, D.D.S., of Boston, president, and G. Everett Mitchell, D.D S., of Haverhill, secretary.

Meetings for the examination of candidates were held this year in March, June and October. The result of these examinations is shown in tabular form as follows: —

MARCH EXAMINATIONS.

Candidates examined, 66.

Passed on first examination,	4	Rejected on first examination,	17
Passed on second examination,	5	Rejected on second examination,	12
Passed on third examination,	2	Rejected on third examination,	10
Passed on fourth examination,	3	Rejected on fourth examination,	4
Passed on fifth examination,	1	Rejected on fifth examination,	3
Passed on seventh examination,	1	Rejected on sixth examination,	1
		Rejected on seventh examination,	2
		Rejected on tenth examination,	1
Total,	16	Total,	50

Non-College Candidates examined, 16.

Passed on fourth examination,	1	Rejected on first examination,	5
Passed on seventh examination,	1	Rejected on second examination,	4
		Rejected on fourth examination,	1
		Rejected on fifth examination,	3
		Rejected on sixth examination,	1
Total,	2	Total,	14

JUNE EXAMINATIONS.

Candidates examined, 150.

Passed on first examination,	80	Rejected on first examination,	28
Passed on second examination,	6	Rejected on second examination,	12
Passed on third examination,	2	Rejected on third examination,	9
Passed on fourth examination,	4	Rejected on fourth examination,	4
Passed on sixth examination,	1	Rejected on fifth examination,	2
		Rejected on seventh examination,	2
Total,	93	Total,	57

Non-College Candidates examined, 11.

Passed on first examination,	1	Rejected on first examination,	1
Passed on second examination,	1	Rejected on second examination,	2
Passed on sixth examination,	1	Rejected on third examination,	5
Total,	3	Total,	8

OCTOBER EXAMINATIONS.

Candidates examined, 78.

Passed on first examination,	6	Rejected on first examination,	18
Passed on second examination,	6	Rejected on second examination,	16
Passed on third examination,	5	Rejected on third examination,	6
Passed on fourth examination,	2	Rejected on fourth examination,	7
Passed on fifth examination,	2	Rejected on fifth examination,	3
Passed on sixth examination,	1	Rejected on sixth examination,	2
Passed on seventh examination,	2		
Passed on ninth examination,	2		
Total,	26	Total,	52

Non-College Candidates examined, 12.

Passed on first examination,	1	Rejected on first examination,	3
Passed on seventh examination,	2	Rejected on second examination,	1
		Rejected on fifth examination,	3
		Rejected on sixth examination,	2
Total,	3	Total,	9

RECAPITULATION FOR THE YEAR 1910.

Candidates examined, 294.

Passed on first examination.	90	Rejected on first examination,	63
Passed on second examination,	17	Rejected on second examination,	40
Passed on third examination,	9	Rejected on third examination,	25
Passed on fourth examination,	9	Rejected on fourth examination,	15
Passed on fifth examination,	3	Rejected on fifth examination,	8
Passed on sixth examination,	2	Rejected on sixth examination,	3
Passed on seventh examination,	3	Rejected on seventh examination,	4
Passed on ninth examination,	2	Rejected on tenth examination,	1
Total,	135	Total,	159

Non-College Candidates examined, 39.

Passed on first examination,	2	Rejected on first examination,	9
Passed on second examination,	1	Rejected on second examination,	7
Passed on fourth examination,	1	Rejected on third examination,	5
Passed on sixth examination,	2	Rejected on fourth examination,	1
Passed on seventh examination,	2	Rejected on fifth examination,	6
		Rejected on sixth examination,	3
Total,	8	Total,	31

Nine cases of violation of the dental law have been reported to the Board during the year. These were duly complained of to the proper authorities and prosecuted in the courts by the regular officers of the law. Each case was fined $50 and costs. Several cases are at the present time being investigated.

The Board of Dental Examiners, though chiefly an examining Board, has taken it upon itself to assist the proper police authorities throughout the State in the enforcement of the dental law. In order that the public may be protected from fraud and incompetency, it becomes the duty of every licensed or registered practitioner to report any violation of the law that he knows to exist. The Board will in turn present the case to the district attorney in the county where the violation occurs, that he may investigate, and, if necessary, prosecute the case. The Board believes that if it received this help and co-operation from the individual licensed practitioner, and also the dental societies, the per cent. of violations of the law would be materially lessened

It sometimes happens that persons carrying on a dental practice with a view of making it a profitable business, while duly authorized themselves, knowingly employ incompetent and unregistered dentists to do the work. In this case the employer is obviously the more guilty of the two, and for this mercenary and criminal collusion ought to be held equally accountable with the employee under the law. It is doubtful whether the present law covers this case. The courts seem to have so decided, and, therefore, the law should be amended accordingly. Except in this particular alone the dental law of Massachusetts would seem to be entirely sufficient to protect the interests of the public and the honor of the profession. Irresponsible dental corporations and fake "dental colleges" have been put out of existence by proper legislation from time to time; our law is often referred to approvingly by the courts of other States, and if properly prosecuted, with the amendment here suggested, would seem to be entirely satisfactory.

The meetings of the Board for the examination of candidates for 1911 will be held in Boston, March 1–3, June 7–9, and October 25–27.

A list of the dentists registered since December, 1909, is appended.

The receipts and expenditures of the Board since the last report are as follows: —

FINANCIAL STATEMENT.

Fees from applicants received and paid into the treasury of the Commonwealth, Dec. 1, 1910,	$3,585 00
Expenditures,	3,582 78

All of which is respectfully submitted.

JOHN F. DOWSLEY, *President.*
G. EVERETT MITCHELL, *Secretary.*

EVANS BUILDING, BOSTON.

SUCCESSFUL CANDIDATES FOR 1910.

March.

Adam, Arthur P. R.
Campbell, Joseph F.
Duprey, Harry C.
Downey, George C.
Gravel, Arthur H.
Gilmartin, Chas. W.
McHugh, Fred
McQuillan, Edwin J.
Paolucei, Albert C.
Richardson, Frank H.
Riddler, George
Shay, George W.
Sherwood, Charles E.
Stetson, Ira B.
Sullivan, Frederick P.
Webster, Arthur C.

June.

Abbott, Ernest A.
Aisner, Julius
Allairs, Albert J.
Austin, Nathan E.
Balderston, Geo. E. B.
Becker, Frederick W.
Billings, Charles H.
Bliss, Orville P.
Brown, Ernest L.
Burke, Eugene E.
Burr, Walter E.
Clegg, William J.
Cooper, Burton C.
Crerie, Fred A.
Davenport, Sebert E.
Dean, Francis H.
Dickinson, Geo. W.
Djinevis, Paul B.
Donnelly, Joseph S.
Donovan, Timothy J.
Dorr, Russell F.
Doubliday, Clark O.
Dunlop, James A.
Dyon, Oscar O.
Eldridge, Melville L.
Ellison, Geo. W., Jr.
Ettelson, Samuel W.
Farrell, Joseph W.
Faulkner, Ralph L.
Feldman, Joseph H.
Finkelstein, Bernard
Fisher, Guy H.
Flood, Charles A.
Fraser, John C.
Gilbert, John R.
Given, Carolus R.
Gower, Stanley M.
Grant, Frederick E.
Haffner, Louis A.
Haley, Robert J.
Hawley, George H.
Henderson, Francis R.
Henneberg, Philip A.
Hoffman, Thomas N.
Holzman, Albert C.
Hoy, Frank
Jellison, Fred G.
Keating, Frank S.
Keith, William F.
Kelly, Charles P.
King, John E.
Kneeland, John P.
Knight, Leroy E.
Knight, Ralph M.
Krensky, Samuel
Lambert, Henry K.
Lingly, Atlee C.

Long, Millard B.
Lynch, Edward M.
MacDonald, Chas. F.
McCabe, Daniel F.
McCarty, David J.
McGlynn, James F.
McGourty, Garrett T.
McGovern, Lawrence P.
Malmstrom, Nels H.
Metcalf, Martin Van Buren
Morse, Edwin J.
Nash, Alfred W.
Norton, Richard H., Jr.
O'Connor, Timothy L.
Palmer, Raymond C.
Pease, George A.
Petzoldt, Rene K.
Quimby, M. Edward
Regan, Francis W.
Riley, Bernard L.
Riley, William J.
Robbins, Horace M.
Rosenthal, Max
Shallen, Isreal M.
Shay, Norbert B.
Small, Wilbert M.
Smith, Ernest J.
Staples, Vincent J.
Steadman, Frederick M.
Sullivan, Anastasia M.
Sweeney, Daniel J.
Thompson, John N.
Turow, Abram A.
Walsh, Jeffrey J.
Welch, Walter H.
Wessler, Myron
Woodell, St. Clair A.

October.

Baker, E. C.
Baker, Ralph V.
Bennett, Allen S.
Campbell, Walter W.
Connors, Maurice C.
Conti, Angelus D.
Ferris, Frederick B.
Foster, Everett C.
Goldstein, Edward A.
House, Clarence E.
Killeen, Dennis J.
Lewis, Charles W.
Lipner, Morris J.
Meade, John J.
Moran, John C.
Nesson, Paul
Parvey, Harry
Rich, Walter I.
Rubin, Joseph
Rubin, Maurice
Siegel, David
Singer, David I.
Tachalana, Yorchi
Teasdale, George M.
Thomas, Oliver J. C.

LIST OF DEATHS REPORTED TO THE BOARD DURING THE YEAR 1910.

Adams, John F.
Bartlette, James W.
Carter, Ernest F.
Grant, George F.
Greenache, C. A.
Hall, Ernest L.
Jordan, Edward
Levy, Joseph
Mayo, Frederick W.
Sawyer, Ralph W.
Shephard, Luther D.
Urbane, P. Pierce

Public Document No. 39

TWENTY-FIFTH ANNUAL REPORT

OF THE

MASSACHUSETTS BOARD OF REGISTRATION IN PHARMACY,

FOR THE

YEAR ENDING NOVEMBER 30, 1910.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1911.

APPROVED BY

THE STATE BOARD OF PUBLICATION.

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METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1910, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, it presents a detailed statement of its doings for the calendar year ending on December 31, 1910, being its

TENTH ANNUAL REPORT

made since the consolidation of the Metropolitan Water Board and the Board of Metropolitan Sewerage Commissioners on March 20, 1901.

I. ORGANIZATION AND ADMINISTRATION.

(1) BOARD, OFFICERS AND EMPLOYÉS.

The term of office of James A. Bailey, Jr., expired on March 21, 1910, and he was reappointed for the three years next succeeding. The membership of the Board has consequently remained as in the preceding year: Henry H. Sprague, chairman, Henry P. Walcott, M.D., and James A. Bailey, Jr. William N. Davenport has continued as secretary and in charge of the auditing department. Alfred F. Bridgman has been the purchasing agent and Miss Alice G. Mason the bookkeeper.

There are also employed in the administrative office a paymaster, an assistant in auditing, two general clerks, three stenographers and clerks, a telephone operator, a messenger, and a janitor with two assistants, one of whom acts as watchman.

George D. Bigelow, with the assistance of Miss Alline E. Marcy, has performed such general conveyancing work and made such further investigation of real estate titles in the different counties as has been called for during the year for the general purposes of the Board.

The consulting engineers of the Board are Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require such consideration.

Dexter Brackett, Chief Engineer of the Water Works, has had supervision over the various departments of both construction and maintenance. William E. Foss, as Assistant to the Chief Engineer, has exercised a general charge over engineering work in all departments. The following have also acted under direction of the Chief Engineer: Elliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct and of all reservoirs and pipe lines within the Metropolitan District; Arthur E. O'Neil, Superintendent of the several pumping stations; Alfred O. Doane, Division Engineer in charge of engineering work at pumping stations; Benjamin F. Hancox, Assistant in charge of the Drafting Department; Arthur W. Walker, Biologist; William W. Locke, in charge of the sanitary inspection of the watersheds; and William E. Whittaker, Office Assistant.

There has been a slight increase in the number in the engineering force on account of a greater amount of construction work in progress during the past year. The average force employed on construction and maintenance during the year has included, in addition to the Chief Engineer, 4 department superintendents, 2 division engineers, 6 assistant engineers, and 39 others in various engineering capacities and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 52. The maximum engineering force employed at any one time during the year on both construction and maintenance was 62.

A maintenance force in addition to those engaged in engineering capacities as above mentioned, numbering upon the average during the year 249, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines, and upon minor construction work. At the end of the year this force numbered 244.

William M. Brown, Chief Engineer of the Sewerage Works, has had charge of both construction and maintenance. He has been assisted during the year by Frank I. Capen, Frederick D. Smith and Henry T. Stiff, Division Engineers, who have been in supervision of both construction and maintenance departments, by 1 assistant engineer and by 13 others employed in various engineering capacities, and by 2 clerks and stenographers.

The maximum engineering force employed at any one time during the year on construction and maintenance of Sewerage Works was 18.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, has upon the average numbered 148.

The whole regular force of the Sewerage Department at the end of the year numbered 167, of whom the Chief Engineer and 18 assistants and draftsmen were engaged in general upon the works, and, of the remainder, 90 were employed upon the North System and 58 upon the South System.

The day-labor forces under the supervision of the engineers and the immediate direction of the foremen have been employed during the year in connection with the extensions of the Deer Island and East Boston pumping stations and their equipment, in the building of the locker and stable buildings at East Boston, and in the completion of the pipe siphons under Alewife Brook.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending April 16, when the number amounted to 143.

(2) Offices and Buildings.

The offices of the Board and of the secretary, and of the auditing and conveyancing departments, and the main engineering offices of both Water Works and Sewerage Works, are located in the buildings numbered 1 and 3 Ashburton Place, at the corner of Somerset Street, in Boston.

The headquarters of the Wachusett Department of the Water Works are at the gate and power house at the Wachusett Dam, in Clinton. The branch office for the Sudbury Department is maintained at South Framingham. Headquarters of the maintenance force of the Water Works for the northern part of the Metropolitan District are maintained in the Glenwood pipe yard in Medford, where there are offices, shops, store-rooms and stables; and the maintenance force for the southern part of the District has headquarters in like buildings at the Chestnut Hill Reservoir.

Branch headquarters of the maintenance and repair forces of the Sewerage Works are maintained for the North Metropolitan System in connection with the East Boston and Deer Island pumping stations, and for the South Metropolitan System at the Ward Street pumping station and at the storage yard at Hough's Neck.

II. METROPOLITAN WATER DISTRICT.

The Metropolitan Water District now comprises the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy and Somerville, and the towns of Arlington, Belmont, Hyde Park, Lexington, Milton, Nahant, Revere, Stoneham, Swampscott, Watertown and Winthrop, — in all 9 cities and 11 towns. The District has an area of 174.8 square miles, no additional municipalities having been admitted into the District during the year. Its population, according to the United States Census taken for April 1, 1910, was 1,070,256. The date upon which calculations for the Water Works are based is July 1, 1910, and the estimate of the population at that date is 1,076,650.

The city of Newton and the town of Hyde Park, though belonging to the District, have not made application to take water from the Metropolitan sources.

III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The total amount expended for the construction and acquisition of the Metropolitan Water Works since the passage of the Metropolitan Water Act in the year 1895 has been $41,546,929.56.

During the past year the amount of construction work has been considerably in excess of that of either of the previous four years. The total amount expended during the calendar year on account of the construction and acquisition of works has been $502,624.92. There has been expended on account of the Wachusett Reservoir, principally in settlement of the claim for the taking of the St. John's Catholic Cemetery, the sum of $35,955.26; the sum of $275,381.04 in the laying of the new 60-inch main for bringing the supply of water from the Weston Aqueduct into the Metropolitan District; the sum of $10,842.71 in the laying of a 16-inch force main in Arlington for the purpose of connecting the pumping station with the standpipe in that town; the sum of $71,320.04 for the reinforcement of the supply of East Boston; the sum of $22,577.50 for the northern high service, largely in the laying of a new 16-inch main in Lynn to reinforce the supply of the town of Swampscott; the sum of $60,892.44 on account of the new pumping engine which is to be installed at Chestnut Hill for the use of the southern high-service district; and the remainder, the sum of $25,655.93, has been expended for stock, other minor works and administration expenses.

(1) WACHUSETT DAM AND RESERVOIR.

(a) *Power Plant.*

In accordance with the recommendations made by the Board the Legislature of the year 1910 passed a statute providing that the property held by the Metropolitan Water and Sewerage Board in the town of Clinton outside of the dam and dike, used in the generation and sale of electricity for power or for manufacturing purposes, shall be assessed on a valuation of $125,000 in any year in which any power is generated and sold.

Before proceeding upon the construction of the power plant it had seemed necessary, inasmuch as the local tax upon such a plant would become so considerable an element in the cost of the power to be disposed of, that the valuation for taxation should be permanently established. The statute of 1910 further provided that the Board, before making a contract for the sale of the electricity, should make public request for proposals for its purchase. The

Board accordingly, after the passage of the act, proceeded to ask for proposals for the purchase of the electricity which might be generated, and as a result a five-year contract was made with the Connecticut River Transmission Company. It was provided in the contract that the Board should install a plant sufficiently large to develop the electric energy available from the fall of the water at the Wachusett Dam, and should also build a transmission line to connect with the transmission line erected by the company for the purpose of making a connection with the Lancaster Mills. The contract recognized that the amount of electric energy available from time to time during the year would be dependent upon the quantity of water which should be introduced into the aqueduct, and that this supply would be increased or diminished and at certain portions of the year wholly suspended, as might be necessary for the purposes of conserving the water supply of the Metropolitan District and utilizing the water supplied from sources nearer Boston.

The Board having made a contract for the sale of power proceeded at once to make plans and specifications for the installation of the necessary machinery in the power house at the foot of the dam. Proposals were invited from the leading hydraulic and electric manufacturing companies, and as a result a contract for installing the machinery required for the development of the power was made with the S. Morgan Smith Company of York, Pa., for both the hydraulic turbines and electric generators, it being understood that the electrical equipment would be furnished under a subcontract with the Westinghouse Electric & Manufacturing Company of Pittsburg, Pa. Work under the contract has already been begun, and its terms provide that it shall be so far completed that power can be furnished to the Transmission Company by July 1, 1911.

(*b*) *St. John's Catholic Cemetery.*

The Board was enabled on May last to bring about a final settlement under the agreement which had been made in the year 1898 with the Roman Catholic Bishop of the Diocese of Springfield and the St. John's Catholic Cemetery Association, by which the land acquired for the old cemetery in Clinton was taken for the Wachusett Reservoir and the bodies removed to a new cemetery site in Lancaster, purchased by the Board for the purposes of the Association.

A deed was received from the Bishop of the Diocese conveying the title to the land, and the Bishop and the Cemetery Association united in a release to the Commonwealth of all claims for damages by reason of the taking. The Board executed a deed to the Association of the cemetery lands in Lancaster and paid over to the Association the sum of $32,096.83, the balance which had long remained payable under the terms of the agreement.

(2) IMPROVEMENT OF THE WATERSHEDS.

No large work has been undertaken during the past year for the improvement of the Wachusett watershed. Two small parcels of land, one of which afforded a menace to a brook emptying into the Wachusett Reservoir, and the other to the reservoir itself, have been purchased for the better protection of the water. A small parcel in Marlborough was purchased for the protection of the Sudbury Reservoir, and four small strips of land along the shore of Lake Cochituate were also acquired to increase the marginal width of the lake.

The construction of a system for diverting the surface drainage of the village of Cochituate from the lake has been carried on by the maintenance department.

It has continued to be the policy of the Board to take such action as from time to time seems necessary in order to suppress the dangers which threaten the purity of the water.

(3) DISTRIBUTION SYSTEM.

(a) *New Weston Aqueduct Supply Main.*

The work of laying the 60-inch supply main which is to afford an additional connection between the Weston Aqueduct and the present mains near the Chestnut Hill Reservoir, and which was begun in the preceding year, has been prosecuted, and of the entire length of about 34,650 feet, 17,584 feet of iron pipe have been laid and 2,042 feet of tunnel have been excavated. The new main is located for the larger portion of the distance through Commonwealth Avenue, beginning near the Charles River in Newton and extending to the junction of Beacon Street and Chestnut Hill Avenue in Boston. It is contemplated at present to construct but a little more than 20,000 feet, being the lower portion ending near the Chestnut

Hill Reservoir, as it is deemed possible, owing to the reduction in the consumption of water in the District, to defer the completion of the remaining portion for the present. There remain principally to be completed in the part under immediate construction the masonry lining of the tunnel in Newton and the laying of 80-inch steel pipes at either end to make connection with the other portions of the line. The tunnel and connecting steel pipes have been made of a sufficient capacity to provide for another pipe line from the Weston Aqueduct in the future. The section under present construction will be brought to completion about the middle of the coming year.

(b) *New Force Main in Arlington.*

A 16-inch force main was laid during the year from Massachusetts Avenue in Arlington up to the standpipe on Arlington Heights, a distance of 3,750 feet. This main was laid in order to improve and make adequate the supply of the high-service districts in Arlington and Lexington and has been completed at a total cost of $10,842.71, inclusive of engineering.

(c) *New Supply Main for East Boston.*

The Legislature of last year authorized the laying of an additional main in order to improve and render more secure the water supply of the East Boston district. For this purpose the Board has proceeded during the year to lay a main, in part 30 inches and in part 36 inches in diameter, from a connection with the Metropolitan main in Chelsea for a distance of about 3,800 feet to a point near the Chelsea Street Bridge, and thence through a tunnel for a distance of about 400 feet under Chelsea Creek to the East Boston side. The tunnel through which the pipe is laid has been constructed with an inner diameter of 6 feet 10 inches at a depth of about 50 feet below the surface of the creek at high water. The construction of the tunnel required the introduction of compressed air, and on account of the difficulty of the work it was determined to proceed by day labor. The tunnel and the laying of the pipe have been nearly completed and it is expected that water will be introduced through the new main early in the coming year.

(*d*) *New 16-inch Main for Swampscott Water Supply.*

As a part of the work which is deemed necessary in order to furnish a proper water supply to the town of Swampscott, a new 16-inch main has been laid through Ocean and New Ocean streets in Lynn to the Swampscott line. The entire cost of this work was $14,009.70.

(*e*) *New Pumping Engine at Chestnut Hill.*

A contract for a new pumping engine having a capacity to pump 40,000,000 gallons per day was made in the year 1909. During the past year the parts of the engine have been received at the Chestnut Hill pumping station, where work of erection has been in progress as well as the construction of foundations for the engine and boilers. Although the engine is to be used for the supply of the southern high-service district it is located in the low-service pumping station. It is expected that the new engine will be placed in service early in the coming year.

(4) ACQUISITION OF LANDS AND SETTLEMENTS FOR DAMAGES.

During the past year the Board has further acquired in fee by purchase 62.706 acres of land, and by taking 0.624 of an acre. It has in addition acquired rights or easements by purchase in 0.133 of an acre, and by taking in 3.42 acres. The total acquisitions of land have thus amounted to 66.883 acres.

The lands acquired embraced three tracts, containing 62.159 acres in West Boylston for the protection of the Wachusett water supply; four parcels in Natick amounting to 0.547 of an acre for the protection of Lake Cochituate; a parcel of land containing 0.516 of an acre in Marlborough for the protection of the Sudbury Reservoir; several parcels in Newton having an aggregate of 3.202 acres for the 60-inch pipe line; a parcel of 0.401 of an acre in Arlington for the extension of the high service; and two parcels in Chelsea and East Boston of 0.0299 of an acre and 0.0325 of an acre, respectively, for the construction of the East Boston tunnel and pipe line.

Under the settlement which was made with the Roman Catholic Bishop of Springfield, a deed was received and a taking was made of the land formerly included in the St. John's Catholic Cemetery in Clinton, amounting to 26.39 acres, although this land had long been in possession of the Board.

The Board has conveyed away, as lands no longer required for its purposes, the lot in Clinton which was formerly occupied for offices for the sum of $3,950; and also a parcel situated between Mystic Street and Old Mystic Street in Arlington for the sum of $1,947. The settlement for the St. John's Catholic Cemetery lands included the release to the St. John's Catholic Cemetery Association of the parcel of land in Lancaster which had been acquired by the Board for the removal of bodies and held for cemetery purposes.

The settlements made during the past year on account of lands purchased and taken have numbered 13. The amount paid, including the balance of $32,096.83 paid in the settlement for the St. John's Catholic Cemetery lands, was $38,507.84. All these settlements have been effected by voluntary agreement.

There have been 9 takings of land for the Metropolitan Water Works, involving the taking in fee of 418.748 acres and easements and rights in 3.424 acres. The takings of lands in Sterling and West Boylston, and in Natick and Framingham, were of lands to which title by deed had previously been acquired. The following is a list of the takings made during the year for Water Works: —

Takings for Metropolitan Water Works for the Year 1910.

No.	LOCATION AND DESCRIPTION.	Former Owner.	Recorded.	Purpose of Taking.
128	Newton, — from Commonwealth Avenue northeasterly across Grant Avenue and Ward Street to Cochituate Aqueduct. Area, fee in 0.108 acre. Easements in 2.381 acres. Rights in 0.580 acre.	John Ward *et al.*, heirs of Francis Pettee, heirs of George K. Ward, William F. Harbach *et al.*, Nehemiah W. Rice *et al.*, Caroline R. Braman and Charles G. Rice.	1910. May 12.	Weston Aqueduct supply mains.
129	Arlington, — from Robbins Road to Park Avenue. Area, easements in 0.401 acre.	Within location of streets or private ways.	May 12.	Northern extra high-service pipe lines.
130	Sterling, — the John Gates farm and adjacent parcels on West Waushacum Pond. Area, fee in 230.71 acres.	Willie R. Mitchell *et al.*, Charles H. Baldwin and West Boylston Manufacturing Company.	May 23.	Improvement of Wachusett watershed.
131	Clinton, — the St. John's Catholic Cemetery. Area, fee in 26.39 acres.	The Roman Catholic Bishop of Springfield.	July 14.	Wachusett Reservoir.
132	Chelsea and East Boston, — parcels near Chelsea Street Bridge on Eastern Avenue, Chelsea, and Chelsea Street, East Boston. Area, easements in 0.0299 acre, Chelsea, and 0.0325 acre and temporary rights in 0.0131 acre, East Boston.	Albert D. Bosson *et al.*, and The Standard Oil Company of New York.	Aug. 13.	Low-service pipe lines.
133	Marlborough, — on an arm of Sudbury Reservoir, both sides of Mowry Brook. Area, fee in 0.516 acre.	The widow and heirs of Philip Mowry.	Sept. 1.	Sudbury Reservoir.

Takings for Metropolitan Water Works for the Year 1910 — Concluded.

No.	Location and Description.	Former Owner.	Recorded.	Purpose of Taking.
134	Natick and Framingham, — outlying and marginal parcels on and near Speene Street and West Central Street, Natick, and on Pleasant Street, Framingham. Area, fee in 6.85 acres.	Westborough Savings Bank, Rufus G. Bayer *et al.*, D. J. Ferguson and Rebecca J. Belknap.	Nov. 1.	Improvement of Sudbury and Cochituate watersheds.
135	West Boylston and Sterling, — outlying parcels, Crescent Street, West Boylston, North Main Street, Oakdale, Waushacum Walk and West Waushacum Pond, Sterling. Area, fee in 16.554 acres.	Mary J. Warner, Walter B. Sawyer, Carrie E. Adams, Willie R. Mitchell *et al.*, and Elmer E. Towle *et al.*	Nov. 1.	Improvement of Wachusett watershed.
136	Sterling, — on East or West Waushacum ponds. Area, fee in 137.62 acres.	West Boylston Manufacturing Company, Frank L. Wilder *et al.*, Willie R. Mitchell and Agnes L. Benfield.	Dec. 21.	Improvement of Wachusett watershed.

IV. WATER WORKS — MAINTENANCE.

(1) Operation of Works.

The maintenance of the Metropolitan Water Works has required the expenditure of $414,121.52 during the past calendar year. There is involved the maintenance and operation of the various storage and distributing reservoirs and standpipes, aqueducts, pumping stations, main pipe lines, filter-beds, pipe yards, gate-houses, siphon and terminal chambers, dwelling houses for attendants, and buildings and other structures used or held for different operating purposes.

(2) Storage Reservoirs.

There are maintained the following reservoirs for the collection and storage of water in the various watersheds which serve as sources of supply for the distribution to the different municipalities: —

	Capacity in Gallons.
Cochituate watershed: —	
Lake Cochituate, including Dudley Pond,	2,242,400,000
Sudbury watershed: —	
Sudbury Reservoir,	7,253,500,000
Framingham Reservoir No. 1,	287,500,000
Framingham Reservoir No. 2,	529,900,000
Framingham Reservoir No. 3,	1,180,000,000
Ashland Reservoir,	1,416,400,000
Hopkinton Reservoir,	1,520,900,000
Whitehall Reservoir,	1,256,900,000
Farm Pond,	167,500,000
Wachusett watershed: —	
Wachusett Reservoir,	64,968,000,000
Total,	80,823,000,000

The full capacity of the reservoirs of 80,823,000,000 gallons was not reached during the year. The total quantity in storage at the beginning of the year was 62,101,500,000 gallons. The maximum quantity of 77,826,500,000 gallons was reached on May 10. During the latter half of the year there was a continual loss of storage, and at the end of the year the total quantity was 59,327,000,000 gallons, a net loss from the beginning of the year of 2,774,000,000 gallons.

The Wachusett Reservoir was not filled to high-water mark at any time during the year. At the beginning of the year the water was 12.91 feet below this mark, and reached its highest point on May 1, when its level was but 0.74 of a foot below high-water mark. There was a gradual loss during the latter part of the year, and at the end the reservoir was 15.65 feet below the high-water level and contained 45,610,400,000 gallons, showing a net loss during the year of more than 3,000,000,000 gallons.

The chief work which has been required in connection with the Wachusett Reservoir has been occasioned by the washing away of the soil at exposed places along the shore through the action of the waves. For an area along the reservoir nearly a mile in length it has been found necessary further to strip the soil in order to keep a proper marginal width.

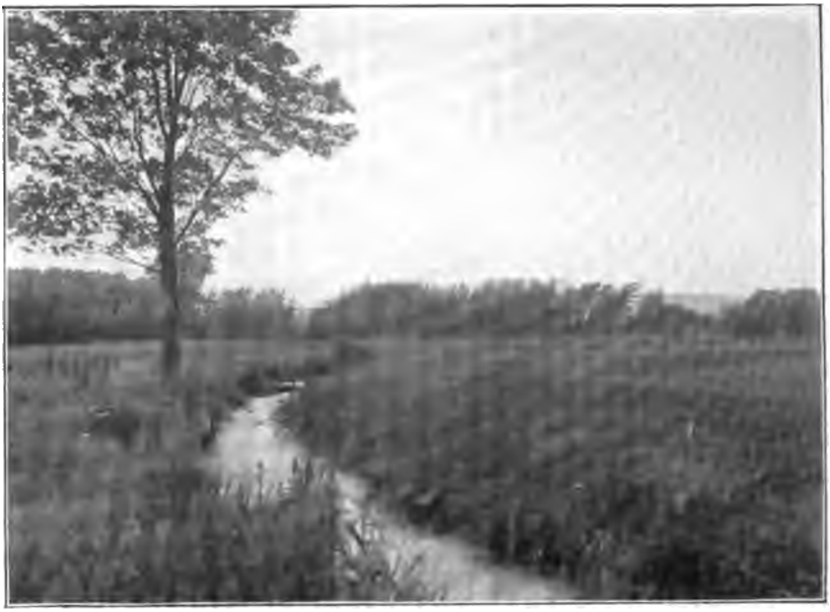
In connection with the discharge of water from the reservoir into the river below, as required by the statute, a fountain has been installed in the pool, which has added an attractive feature to the grounds.

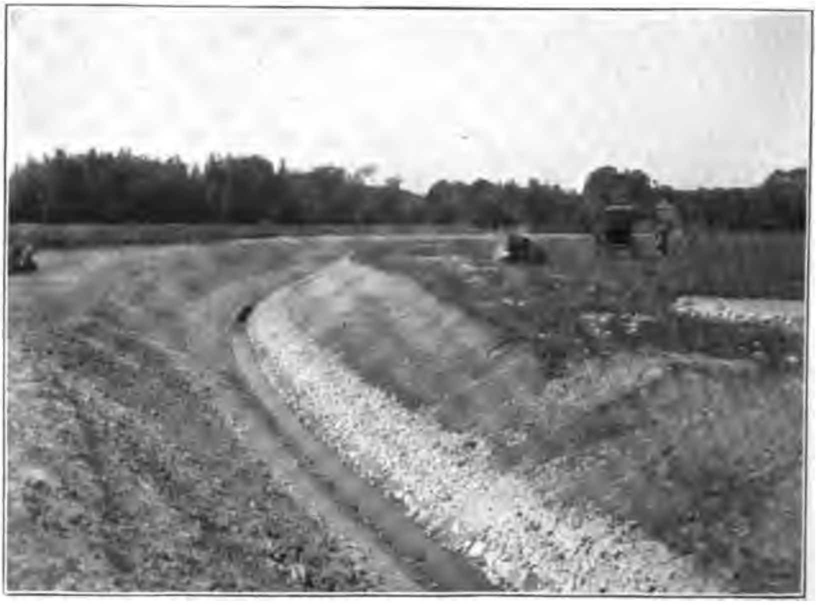
All the water taken from the Wachusett Reservoir was carried into the Sudbury Reservoir and thence in large part through Framingham Reservoir No. 3 into the Metropolitan District, and both these latter reservoirs were kept full or nearly full during the year.

It being deemed preferable to draw the water from the Wachusett supply, the other Framingham reservoirs and the Ashland, Hopkinton and Whitehall reservoirs, having independent sources, were not drawn upon during the year.

Water has been drawn from Farm Pond, through a filter gallery alongside of the pond, by the town of Framingham for the larger part of its supply, but a comparatively small portion has also been taken by the town directly from the Sudbury Aqueduct.

Several small strips of land along the shore of Lake Cochituate





IMPROVEMENT OF LAKE COCHITUATE—Appearance south of County Road in Framingham before and after Drainage Work.

have been purchased during the year in order to add to the width of the marginal land under the control of the Board, and better to protect the water of the lake from pollution.

The principal measure, however, which has been taken for the protection of the water supply has been the construction of a system of surface drainage, which is to take the surface water from the village of Cochituate now flowing into Snake Brook, a tributary of the lake, and divert it into Bannister's Brook, which flows into the Sudbury River and outside of the Cochituate watershed. A large vitrified pipe is laid from Main Street in Cochituate village to the junction with Hammond's Brook, and thence a concrete covered drain 36 inches by 33 inches in dimensions has been constructed substantially along the County Road for a distance of 3,454 feet to a point beyond the town line of Natick, whence an open channel, with a bottom width of 12 inches, has been built for a distance of 5,958 feet, following an old drain to Bannister's Brook, and through the brook to an old mill-pond north of the County Road and west of Speene Street in Framingham.

The contract for this undertaking had been almost completed at the end of the year. An appropriation amounting to $36,000, chargeable to maintenance, had been made for this improvement. The sum of $26,883.44 has been so far expended, but the total cost will come considerably within the appropriation.

The prosecution of the work required the lowering of the water of the lake for a considerable period, and for this reason and on account of the excavation of the tunnel in Newton for the new 60-inch pipe in close proximity to the Cochituate Aqueduct, it has been deemed best not to draw water from Lake Cochituate, as has been usually done during a portion of the year.

(3) AQUEDUCTS.

Nearly all the water consumed in the Metropolitan District was brought from the Wachusett Reservoir, and consequently was carried through the Wachusett Aqueduct into the Sudbury Reservoir. The average number of gallons per day thus carried through the Wachusett Aqueduct was 103,146,200. The Wachusett Aqueduct was in operation during 340 days in the year.

From the Sudbury Reservoir water was discharged into Framingham Reservoir No. 3, and thence an average of 85,033,000 gallons per day was drawn through the Sudbury Aqueduct to the Chestnut Hill Reservoir. This aqueduct was in continuous service during the entire year.

The Weston Aqueduct was also continuously operated during the year, and the daily average flow was 28,974,000 gallons. This water was taken directly from the Sudbury Reservoir.

No water was drawn through the Cochituate Aqueduct for the use of the District during the year, but the aqueduct was kept in condition ready for use if called upon at any time.

(4) DISTRIBUTING RESERVOIRS AND STANDPIPES.

The distributing reservoirs and standpipes located in different parts of the Metropolitan District have a total capacity of 2,381,230,000 gallons. These reservoirs are kept substantially full during the year, not only as a protection and relief in cases of accident or emergency, but also in order to secure a proper distribution of the water throughout the District. They are as follows: —

	Capacity in Gallons.
Spot Pond,	1,791,700,000
Chestnut Hill Reservoir,	300,000,000
Weston Reservoir,	200,000,000
Fells Reservoir,	41,400,000
Mystic Reservoir,	26,200,000
Waban Hill Reservoir,	13,500,000
Forbes Hill Reservoir,	5,100,000
Bear Hill Reservoir,	2,450,000
Arlington Standpipe,	550,000
Forbes Hill Standpipe,	330,000
Total,	2,381,230,000

(5) PUMPING STATIONS.

While about one-quarter of the water introduced into the Metropolitan District has been supplied by gravity, the remainder, or three-quarters of the whole, has been lifted by pumping at the two Chestnut Hill stations in order that it may be delivered in the various portions of the District at the requisite pressure. A portion of the water is necessarily lifted a second time for the supply of the higher sections.

The following are the several pumping stations: —

	Number of Engines.	Maximum Contract Capacity per Day (Gallons).	Lift (Feet).
Chestnut Hill High-service Station, . .	4[1]	66,000,000	138
Chestnut Hill Low-service Station, . .	3	105,000,000	60
Spot Pond Station, ...	2	30,000,000	125
Arlington Station, ...	2	3,000,000	290
West Roxbury Station, ...	3	3,750,000	140

[1] The new pumping engine in process of erection for the high service, to be located in the low-service station, will have a maximum contract capacity of 40,000,000 gallons per day, with a lift of 130 feet.

An average of 84,654,000 gallons was daily pumped from the two Chestnut Hill stations, and in the other stations an average of 8,995,000 gallons was daily pumped.

The total cost of operating all the stations during the year was $101,996.34, or $2.99 per million gallons pumped. Of this total, $61,933.82 was expended for labor and $34,332.78 for fuel.

The total amount of coal purchased during the year was 9,693.63 gross tons, of which 6,941.47 tons were bituminous, 314.53 tons anthracite, 2,101.77 tons buckwheat anthracite, and 335.86 tons anthracite screenings. The average cost of bituminous coal delivered in the bins at the various stations varied from $3.85 to $4.82; the average cost of anthracite coal was $4.91; the cost of buckwheat varied from $2.59 to $2.76, and of anthracite screenings from $2.50 to $2.68.

All the bituminous coals purchased are subjected on delivery to strict tests as to their heating power and as to the amount of moisture contained, and it is provided in the contracts for furnishing the coal that a deduction shall be made when the coal falls below a fixed standard, and at the same time the price is increased if it is found to be superior to the standard required.

(6) PIPE LINES.

There has been during the past year an increase in the length of main pipe lines owned and operated by the Metropolitan Water and Sewerage Board of 4.49 miles, the total length of the mains now owned and in operation being 97.02 miles. The Metropolitan mains are operated in connection with local mains 4 inches and more in diameter, by which the water is distributed to the various municipalities of the District, and which have a length of 1,633.37 miles.

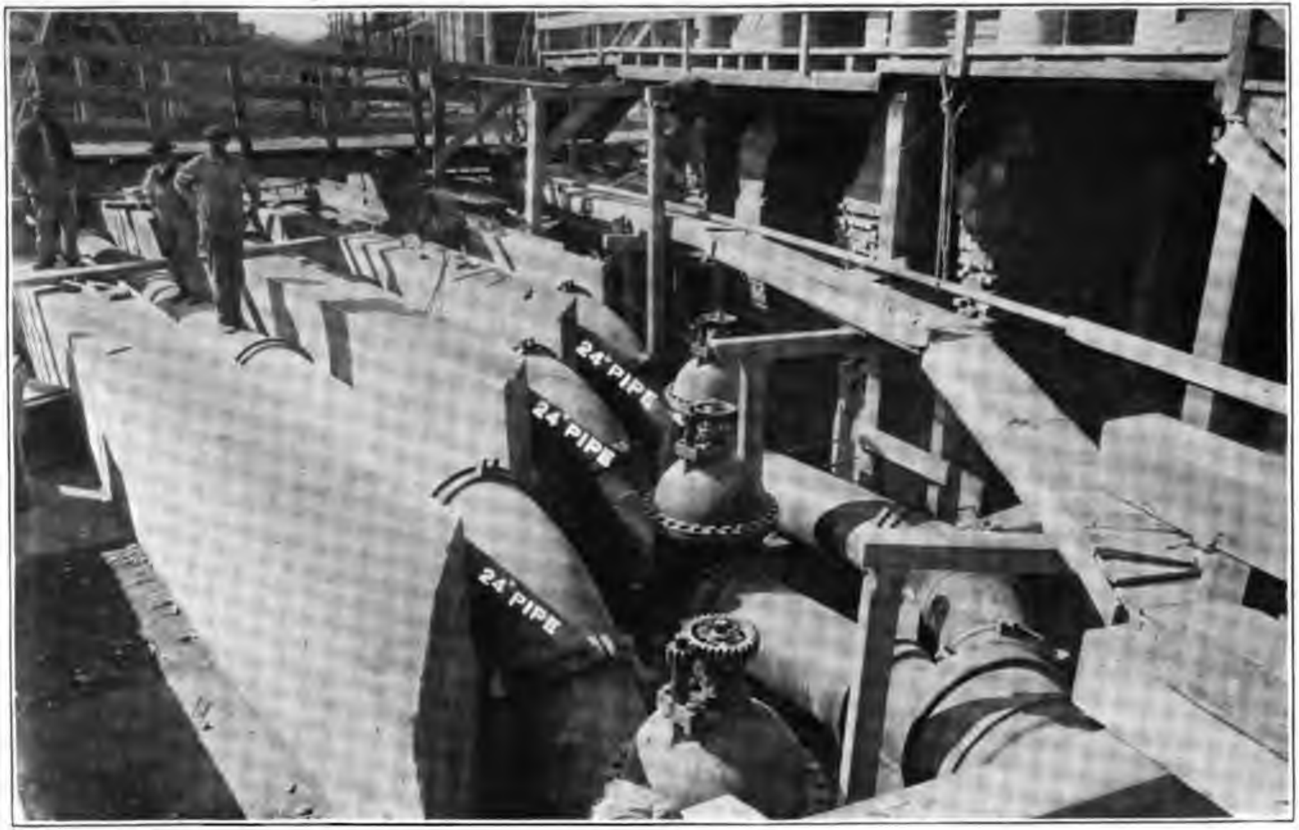
The principal addition to the mains has been the laying of about 2⅓ miles of the 60-inch supply main from the Weston Aqueduct, but the new line for the improvement of the East Boston supply, the line in Lynn for the reinforcement of the Swampscott supply, and the line between the pumping station and standpipe in Arlington, have added considerable to the total mileage.

Several changes in mains have been required during the past year, largely on account of construction of other public works.

The construction of the subway station at Harvard Square in Cambridge by the Boston Elevated Railway Company compelled a change in the 48-inch main running through Boylston Street and Massachusetts Avenue for a distance of about 650 feet. For a portion of the distance three 24-inch mains were substituted for the original 48-inch main. This work involved much difficulty, and was performed in part by the Board at the expense of the company and in part by the Boston Elevated Railway Company itself.

Other changes found necessary have been the lowering of the 48-inch main in Reservoir Lane in Brookline near the Chestnut Hill high-service pumping station for a distance of 275 feet, in order to permit the construction of Crafts Road across the lane; the lowering of the pipe under the Mystic River between Medford and Arlington for a distance of 130 feet to permit the deepening of the channel by the Metropolitan Park Commission; and a relocation of the main in Morton Street in West Roxbury in order to conform to the new location of a branch of the Stony Brook conduit made by the city of Boston.

It has also been necessary to relay a portion of the 48-inch main in Boylston Street, Cambridge, on account of the destructive effects of electrolysis upon the pipes.



Substituting three 24-inch Pipes for 48-inch Pipe in Main at Harvard Square, Cambridge.

No breaks in the mains have occurred during the year, but there have been discovered and repaired 45 leaks in pipe lines. Several of the leaks occurred in the pipes laid under the Charles and Mystic rivers, and in the repairs resort was necessarily had to dredging machines and divers. The larger part of the leaks occurred at leaded joints, and were in many cases due to settlement of the pipes on account of adjacent excavations made in the prosecution of other public work.

The Venturi and other meters, by which the water delivered to the various municipalities is measured, have been the efficient means of detecting leaks in the local systems which failed to be discovered by the authorities themselves. Two notable leaks, in each case amounting to about 1,000,000 gallons per day, were, through the indications of the meters, found in Medford and in Brighton, the water escaping in one case into the river and in the other into a sewer.

(7) Clinton Sewerage Works.

The Clinton Sewerage Works have been operated under the requirements of the Metropolitan Water Act in order to dispose of the sewage of the town, which had formerly been discharged into the South Branch of the Nashua River before the principal portion of the water was diverted for the Metropolitan supply.

About 829,000 gallons of sewage per day have been pumped upon the filter-beds, at a total cost of $3,545.92, or of $11.72 per million gallons pumped.

A considerable improvement in the efficiency of the filter-beds has been effected by continuing the work previously begun of constructing underdrains and of placing distributing channels over the surfaces of the beds.

In addition to the 29 beds before constructed, 2 new beds have been built during the past year in a more isolated location in order to receive the sludge from the settling basins, into which the sewage is directly pumped.

The measures which have been taken have brought about a decided improvement in the character of the effluent discharges. The sludge which has gathered has been used as fertilizer for the grass lands in the vicinity of the Wachusett Dam and the North Dike.

The sum of $3,353.42 was expended in the required maintenance of the filter-beds, and an additional sum of $4,895.61 was spent upon the improvements.

(8) PROTECTION OF THE WATER SUPPLY.

Various means have been employed in connection with the maintenance of the works in order to preserve the purity of the water supplied to the District and to protect it from pollution.

(a) *Pegan Brook Filtration Works.*

In the work of protecting the waters of Lake Cochituate about 577,550 gallons per day of the surface drainage which comes from the more thickly settled portions of the town of Natick have been collected and pumped upon filter-beds before the water of the brooks intercepted is allowed to enter the lake. The cost of maintaining and operating the pumping station and the filter-beds has been $2,606.47, or $12.77 per million gallons treated.

(b) *Marlborough Brook Filter-beds.*

The surface water from the thickly settled portions of the city of Marlborough, flowing into Marlborough Brook, has been diverted into a settling basin and thence into filter-beds, before it has been admitted into the Sudbury Reservoir. During a few days only in the year has diluted sewage overflowed from the Marlborough sewer mains into the brook. The filters have been sufficient to dispose of all the waters of the brook except upon two days of heavy storm.

(c) *Sterling Filter-beds.*

The filter-beds constructed on the brook which flows through the centre of the town of Sterling and into Lake Waushacum have been in continuous and successful operation through the year. The smaller filter-beds at Sterling Junction, which were built to intercept the sewage of the summer cottages and prevent the pollution of the Waushacum Brook, a direct tributary of the Wachusett Reservoir, have been kept in operation during the summer season.

(*d*) *Drainage Ditches.*

The ditches which have been built for an aggregate length of 36.36 miles, in order to provide a quick drainage of the principal swamps upon the several watersheds and to prevent the discoloration and deterioration of the water flowing from them into the various storage reservoirs, require from year to year not only regular oversight but many repairs and renewals. These have involved a considerable expense, amounting to $2,315.65, but the result has been satisfactory in the improvement of the quality of the water.

(*e*) *Sanitary Inspection and Policing.*

A sanitary inspector, William W. Locke, C.E., and one assistant have been continuously engaged, and others to the maximum of 15 in number have been employed for various periods during the year, in the inspection of the watersheds, not only for the purpose of remedying minor sources of pollution but also for the more general protection from injury of the property of the Commonwealth.

The sanitary inspectors have examined 1,481 premises on the Wachusett watershed and 7,226 premises on the Sudbury and Cochituate watersheds with reference to cesspools, privy, sink and barn drainage, manufacturing wastes and sewer connections.

During the year a census has been made, showing in the different sections of the watersheds the permanent and summer populations, the number of dwellings occupied permanently and in the summer, the population unconnected with sewers, and the numbers of domestic animals which are kept. The tables, which are given in the report of the Chief Engineer of Water Works, indicate a decided improvement in the sanitary condition of the watersheds during the last five years, and show that the number of premises deemed "unsatisfactory," that is, those from which trouble may possibly arise under unfavorable circumstances, have been greatly reduced.

These tables show that upon the Wachusett watershed the total permanent population is 44.7 per square mile of area, and that on the Sudbury and Cochituate watersheds the population in dwellings not connected with sewers is respectively 129.7 and 260.4 per square mile.

There were 3 cases of typhoid fever reported on the Wachusett watershed and 130 cases upon the Sudbury and Cochituate watersheds. All these cases were carefully watched, and measures, which were entirely successful, were adopted to prevent the pollution of the water supply.

A more general patrol for the protection of the water supply has been required during more or less of the year. Three officers are regularly employed in the policing of the Wachusett and Sudbury systems, though other duties are assigned them in connection with this employment. Two watchmen were employed about Lake Cochituate in the summer and camping season and while a large gang of laborers was engaged on public works in the vicinity. The large number of persons visiting the grounds about the Chestnut Hill reservoirs and Spot Pond in the summer season has made it necessary, for the more effective protection both of the water supply and of the property of the Commonwealth, to employ patrolmen more or less on Saturdays, Sundays and holidays, and for the purpose men have generally been detailed from other duties. These various efforts have been successful in preventing any serious injury.

(*f*) *Laboratory Examinations.*

Weekly and monthly examinations are made in the laboratory of the Board to ascertain the number of organisms and bacteria contained, and to determine the color, taste, odor and turbidity of the water of the various reservoirs and of the various tributaries which feed the larger sources from which the supply is taken. There have thus been made 2,377 microscopical and 961 bacterial examinations during the year. Samples are also sent for monthly and bi-monthly chemical examination at the laboratory of the State Board of Health. These examinations not only enable the quick detection of objectionable organisms or other substances in the water, but make it possible to draw the water for immediate use in a large measure from sources where the most favorable conditions exist.

(9) QUALITY OF THE WATER.

The water drawn from the Wachusett and Sudbury reservoirs, which have furnished almost the entire supply during the year, has been peculiarly free from objectionable organisms. Other disturbing elements have also been lacking, and the water furnished the District has been of exceptionally good quality.

(10) FORESTRY AND MOTH SUPPRESSION.

The lands under the custody of the Board comprise about 10,000 acres, and the larger part of these are embraced in the margins surrounding the great reservoirs, particularly the Wachusett Reservoir. For the better protection of the water of the reservoirs it has been the policy of the Board to plant with trees the larger part of the territory which was not already wooded. The original nurseries, the Lamson and Flagg nurseries, maintained on the north and south sides of the Wachusett Reservoir, will gradually give way to a single new nursery which has been started on Waushacum Street in Oakdale.

The work about the Wachusett Reservoir during the past year has consisted principally in replanting sections along the immediate margins in order to supply the places of trees which had died, the thinning out of portions of the old woodlands, the improvement of forest roads and the planting of trees along the highways.

A considerable number of arbor vitæ trees have been set out on the shores and lands about the Sudbury Reservoir, white pines have been planted on portions of the shore about Lake Cochituate and along the Sudbury Aqueduct, and other trees have been set out along the Weston Aqueduct and at Spot Pond.

The ravages of the gypsy and brown-tail moths, the elm-leaf beetle and the pine-tree weevil have continued on various parts of the lands under the custody of the Board, and the sum of $6,010.21 has been spent in the efforts to suppress them, an amount about $2,000 less than that called for in the preceding year.

The moths have been encountered, though in somewhat less numbers, at Spot Pond, at the Chestnut Hill Reservoir, and also at the Sudbury and Weston reservoirs, and along portions of the aqueducts. A few moths have been discovered the past year in the vicinity of the Wachusett Reservoir. At the Weston Reservoir the elm-leaf beetle has been more than ever prevalent and destructive. At the Wachusett Reservoir the pine-tree weevil infested the young pines more than in previous years, and it was also alike destructive at the Sudbury Reservoir.

(11) ELECTROLYSIS.

Owing to the destructive effects of the passage of the electric currents through the line of iron pipes, it was deemed unsafe to defer longer the substitution of new pipes in that section of the 48-inch main line which runs through Boylston Street in Cambridge from the vicinity of the power station of the Boston Elevated Railway Company near the Charles River, to Eliot Street, not far from Harvard Square. The section replaced had a length of 827 feet and had been laid but a period of fourteen years. The new pipes have a thickness of 1.7 inches instead of the original thickness of 1.4 inches and, excepting at a curve, were laid with joints of wood instead of lead in order to secure insulation in the future. Pittings more or less deep and extended were found in all the discarded pipes, generally from ½ inch to at least 1 inch in depth. In one of the lengths removed the pipe was so affected that four holes were made in cleaning out the pittings which had been caused by the action of the electric current.

The cost of relaying this section of the main was $12,221.40, and is made a claim against the Railway Company.

The insertion of wooden instead of lead joints at intervals of about 500 feet has been adopted in all the lines of main pipe which have been recently laid, and it is believed that this is the most efficient means for the prevention or checking of electrolysis in the pipes which has yet been found.

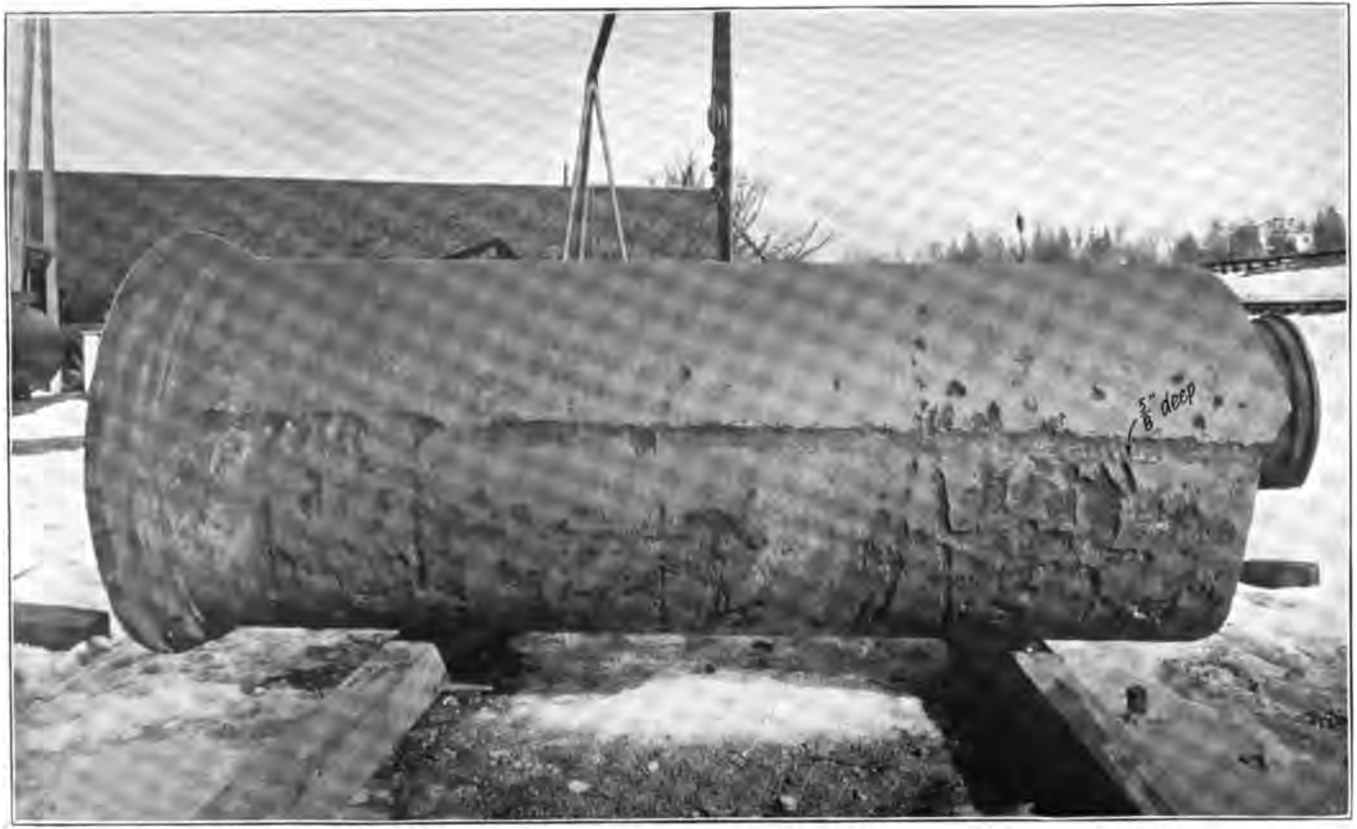
It is undoubtedly true, however, that great damage has been done in the past by the electrolytic action upon the pipes in various parts of the District, seriously weakening them in case of extraordinary pressure and decidedly shortening the period of their safe use.

V. WATER WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1909, and ending with November 30, 1910, was, in accordance with the requirements of chapter 235 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 5.

The more detailed statement of its doings required by said chapter for the calendar year 1910, in relation to the Metropolitan Water Works, is herewith presented.

The Metropolitan Water Loans authorized for the construction and acquisition of works have amounted to $41,878,000. To this



Effect of ELECTROLYSIS upon 48-inch Main Pipe in Boylston Street, Cambridge.

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sum are added the proceeds from the sale of property by the Board, and these amounted on January 1, 1911, to $288,574.04. The total amount, therefore, which the Board has been authorized to expend is $42,166,574.04. The amount of expenditures approved by the Board for payment out of the Metropolitan Water Loan Fund was, for the year 1910, $502,624.92, and the total amount so approved for payment since the beginning of the work up to January 1, 1911, has been $41,546,929.56. There was accordingly a balance remaining at the beginning of the year 1911 amounting to $619,644.48.

The Treasurer of the Commonwealth has issued from time to time, on the request of the Board, bonds to the amount of $41,398,000. These bonds were issued for terms of thirty-nine and one-half and forty years from the date of issue, and bear interest at the rate of 3 per cent. and 3½ per cent. per annum. The sinking fund established for the payment of the bonds at maturity amounted on January 1, 1911, to $8,089,902.91.

The increase in the debt, during the calendar year, as represented by the Metropolitan Water Loans outstanding, was $500,000. The increase of the sinking fund for the payment of the debt at maturity was during the same period, $863,640.60. There has been, therefore, a decrease of the net debt during the calendar year amounting to $363,640.60.

The amount approved by the Board for the maintenance and operation of the Water Works for the year 1910, which was paid out of the annual assessments, was $414,121.52.

The assessments for the year 1910 for the payment of interest on the bonds, for the sinking fund requirements and for the expenses of operation and maintenance of the Water Works, which were levied upon the various cities and towns in the Metropolitan District, amounted to $2,297,787.77.

(1) METROPOLITAN WATER LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction and acquisition of the Metropolitan Water Works, the receipts which are added to the proceeds of these loans, the expenditures for the construction and acquisition of works, and the balance available on January 1, 1911, have been as follows: —

Loan under chapter 488 of the Acts of 1895,		$27,000,000 00
Loan under chapter 453 of the Acts of 1901,		13,000,000 00
Loan under chapter 367 of the Acts of 1906,		500,000 00
Loan under chapter 558 of the Acts of 1908,		398,000 00
Loan under chapter 320 of the Acts of 1909,		900,000 00
Loan under chapter 291 of the Acts of 1910,		80,000 00
		$41,878,000 00
Receipts from the sales of property applicable to the construction and acquisition of works: —		
For the year ending December 31, 1910,	$31,502 38	
For the period prior to January 1, 1910,	167,071 66	
		198,574 04
Receipt from town of Swampscott for admission to the Metropolitan Water District paid into Loan Fund (St. 1909, c. 320),		90,000 00
		$42,166,574 04
Amount approved by the Metropolitan Water and Sewerage Board for payments out of the Water Loan Fund: —		
For the year ending December 31, 1910,	$502,624 92	
For the period prior to January 1, 1910,	41,044,304 64	
		41,546,929 56
Balance January 1, 1911,		$619,644 48

(2) ISSUES OF METROPOLITAN WATER LOAN BONDS.

The Treasurer of the Commonwealth, under the authority given him to issue from time to time, on the request of the Board, negotiable bonds to an amount not exceeding $41,878,000, to be designated the "Metropolitan Water Loan," has sold bonds to the amount of $41,398,000. The list of bonds sold prior to the year 1910 is given in the last (Ninth) Annual Report. The bonds sold in the year 1910 are as follows: —

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
Feb. 10, 1910,	$500,000	3½	100.39	Jan. 1, 1950	$1,950 00

Prior to May 1, 1906, all premiums received from the sales of bonds were applied to the payment of the current charges in reduction of the annual assessments, but since that date, under the provisions of chapter 337, Acts of 1906, they have been paid into the sinking fund.

(3) METROPOLITAN WATER LOAN SINKING FUND.

The sinking fund established by the Treasurer of the Commonwealth has amounted at the end of each year to sums as follows: —

December 31, 1895, .	$226,286 05	December 31, 1903, .	$2,877,835 59
December 31, 1896, .	699,860 70	December 31, 1904, .	3,519,602 92
December 31, 1897, .	954,469 00	December 31, 1905, .	4,207,045 69
December 31, 1898, .	1,416,374 29	December 31, 1906, .	4,897,822 62
December 31, 1899, .	1,349,332 97	December 31, 1907, .	5,643,575 69
December 31, 1900, .	1,573,619 72	December 31, 1908, .	6,419,283 28
December 31, 1901, .	1,662,426 95	December 31, 1909, .	7,226,262 31
December 31, 1902, .	2,256,803 81	December 31, 1910, .	8,089,902 91

(4) ANNUAL ASSESSMENTS AND RECEIPTS.

Assessments for the year, amounting to $2,297,787.77, were required for the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements and the expenses of operation and maintenance of the Water Works. The requirements were: for interest, $1,395,201.95; for the sinking fund, $522,344.24; and for maintenance and operation, $380,241.58. These assessments were made by the Treasurer of the Commonwealth upon the various municipalities as follows: —

Arlington, ...	$16,241 07	Nahant, ...	$4,357 11
Belmont, . . .	6,812 68	Newton, ...	6,370 34
Boston, ...	1,815,658 85	Quincy, ...	50,950 31
Chelsea, ...	47,716 42	Revere, ...	23,139 93
Everett, ...	45,937 13	Somerville, . . .	110,056 25
Hyde Park, . . .	1,316 24	Stoneham, ...	9,670 13
Lexington, ...	7,501 34	Swampscott, . . .	9,547 88
Malden, ...	42,302 82	Watertown, . . .	16,082 35
Medford, ...	32,690 39	Winthrop, ...	16,681 77
Melrose, ...	19,640 91		
Milton, ...	15,113 85		$2,297,787 77

The comparatively smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of these municipalities had reached the safe capacity of its own sources of water supply, and neither had been furnished with water.

The proceeds from the operations of the Board, exclusive of the proceeds from sales of property and of water, are required by statute to be applied to the payment of the interest, the sinking fund requirements and expenses of maintenance and operation of works. These for the year 1910 amounted to $26,929.32.

The amount approved by the Board for the maintenance and operation of the Metropolitan Water Works was, for the year 1910, $410,121.52.

(5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF DISTRICT AND TO WATER COMPANIES.

Sums have been received during the year 1910, under the provisions of the Metropolitan Water Act, for water furnished, as follows: —

Town of Framingham,	$559 20
United States Government,	1,954 46
Westborough State Hospital,	1,433 88
	$3,947 54

The sums so received prior to March 23, 1907, were annually distributed among the cities and towns of the District, but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works: —

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
Administration applicable to all parts of the construction and acquisition of the works,		$6,999 78		$288,453 07
Wachusett Dam and Reservoir: —				
Wachusett Dam,	$288 27		$2,378,195 28	
Power plant,	2,243 06		2,436 06	
North Dike,	-		792,264 68	
South Dike,	-		137,075 55	
Amounts carried forward,	$2,531 33	$6,999 78	$3,309,971 57	$288,453 07

Construction and Acquisition of Works.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
Amounts brought forward,	$2,531 33	$6,999 78	$3,309,971 57	$288,453 07
Wachusett Dam and Reservoir — *Concluded.*				
Removal of soil,	-		2,536,612 66	
Relocation of railroads,	-		881,872 45	
Roads and bridges,	-		547,867 76	
Real estate,	33,423 93		3,240,189 06	
Damages, real estate not taken, business and loss of wages,	-		532,247 07	
Other expenses,	-		8,547 92	
		35,955 26		11,057,308 49
Improving Wachusett watershed,		2,636 20		231,128 77
Wachusett Aqueduct,		-		1,797,948 85
Sudbury Reservoir,		13 25		2,923,146 96
Protection of Sudbury supply,		-		129,190 36
Improving Sudbury watershed,		-		95,711 84
Protection of Cochituate supply,		-		9,000 00
Improving Cochituate watershed,		-		8,860 68
Improving Lake Cochituate,		-		104,141 29
Pipe lines, Dam No. 3 to Dam No. 1,		-		48,471 48
Pipe line, Rosemary siphon,				23,142 98
Weston Aqueduct: —				
Aqueduct,	-		$2,353,820 11	
Reservoir,	-		289,001 82	
Real estate, taxes and other expenses,	-		206,668 18	
		-		2,849,490 11
Distribution system: —				
Low service: —				
New 48-inch main, Section 31,	-		$162,698 06	
Section 38, Tunnel (East Boston main),	$32,322 27		32,322 27	
Pipe lines and connections,	38,957 77		1,791,985 02	
Pumping station, Chestnut Hill,	-		462,572 19	
Reservoir, Spot Pond,	-		582,188 73	
Gate-house and connections, Chestnut Hill Reservoir,	-		65,480 88	
Real estate and other expenses,	1,210 61		92,936 17	
Northern high service: —				
Pipe lines and connections,	22,577 50		527,485 76	
Spot Pond pumping station,	-		291,829 35	
Fells Reservoir, Stoneham,	-		141,392 94	
Bear Hill Reservoir, Stoneham,	-		38,267 70	
Real estate and other expenses,	-		14,838 05	
Southern high service: —				
Pipe lines and connections,	350 12		516,211 06	
Pumping station, Chestnut Hill,	60,542 32		307,694 70	
Forbes Hill Reservoir, Quincy,	-		90,003 49	
Waban Hill Reservoir, Newton,	-		61,592 11	
Real estate and other expenses,	-		10,226 36	
Amounts carried forward,	$155,960 59	$45,604 49	$5,189,724 84	$19,565,994 88

Construction and Acquisition of Works.		For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
Amounts brought forward,		$155,960 59	$45,604 49	$5,189,724 84	$19,565,994 88
Distribution system — *Concluded.*					
Northern extra high service,		10,842 71		101,797 77	
Southern extra high service,		16 00		22,871 27	
Weston Aqueduct supply mains,		275,671 44		959,425 58	
Meters and connections,		2,170 11		84,615 69	
Improving Spot Pond Brook,		-		3,991 23	
Glenwood pipe yard,		-		33,100 59	
Chestnut Hill pipe yard,		-		11,311 26	
			444,660 85		6,406,838 23
Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work: —					
Amount received,		$199,162 23		$2,471,141 97	
Transferred from storage yards to the various sections of the work and included in costs of special works,		186,802 65		2,320,946 81	
			12,359 58		150,195 16
Diversion of water, South Branch of Nashua River,[1]			-		1,363,935 31
Acquisition of existing water works: —					
Reimbursement city of Boston, partially constructed Reservoir,		-		$1,157,921 59	
Boston water works, taken January 1, 1898,		-		12,768,948 80	
Spot Pond taken from Malden, Medford and Melrose,		-		1,240,229 62	
Waban Hill Reservoir purchased from Newton,		-		60,000 00	
Expenses: —					
Engineering,	$22,617 52				
Conveyancing,	3,862 92				
Legal, expert and court,	46,648 03				
				73,128 47	
Deduct following, transferred and charged to special works: —					
Reimbursement city of Boston, transferred to Sudbury Reservoir,	$1,157,921 59				
Waban Hill Reservoir transferred to Distribution Department,	60,000 00				
Stock — pipes, engines, etc., included with Boston Water Works and transferred to Distribution Department,	22,340 91				
				1,240,262 50	
					14,059,965 98
Total for construction and acquisition of works,			$502,624 92		$41,546,929 56

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[1] Of the total expenditures from the beginning of the work, the sum of $150,939.89 is for Clinton sewerage system.

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1910.	
Administration,	. . .	$13,533 81
General supervision,	. . .	31,296 03
Taxes and other expenses,	. . .	36,030 04
Wachusett Reservoir Department: —		
Superintendence,	$9,615 88	
Reservoir,	4,037 59	
Forestry,	6,718 58	
Protection of supply,	2,465 86	
Buildings and grounds,	2,863 21	
Wachusett Dam,	4,902 00	
Wachusett Aqueduct,	2,024 47	
Clinton sewerage system: —		
Pumping station,	3,576 88	
Sewers, screens and filter-beds,	11,174 31	
Sanitary inspection,	2,519 60	
Swamp drainage,	2,315 65	
		52,214 03
Sudbury Department: —		
Superintendence, Framingham office,	$8,058 23	
Ashland Reservoir,	1,272 74	
Hopkinton Reservoir,	1,734 87	
Whitehall Reservoir,	466 60	
Framingham Reservoirs Nos. 1, 2 and 3,	6,261 02	
Sudbury Reservoir,	6,034 22	
Lake Cochituate,	7,160 87	
Marlborough Brook filters,	2,462 87	
Pegan filters,	2,913 20	
Sudbury and Cochituate watersheds,	858 48	
Sanitary inspection,	3,467 92	
Cochituate Aqueduct,	4,026 23	
Sudbury Aqueduct,	6,036 98	
Weston Aqueduct,	4,387 92	
Improving Lake Cochituate,	26,459 54	
		82,201 69
Distribution Department: —		
Superintendence,	$4,256 54	
Arlington pumping station, pumping service,	7,350 04	
Chestnut Hill low-service pumping station, pumping service,	31,487 05	
Chestnut Hill high-service pumping station, pumping service,	42,136 74	
Spot Pond pumping station, pumping service,	13,834 71	
West Roxbury pumping station, pumping service,	6,382 79	
Arlington standpipe,	29 25	
Bear Hill Reservoir,	134 58	
Chestnut Hill Reservoir and grounds,	10,292 59	
Fells Reservoir,	597 40	
Forbes Hill Reservoir,	1,033 52	
Mystic Lake, conduit and pumping station,	1,260 82	
Mystic Reservoir,	944 43	
Waban Hill Reservoir,	340 25	
Amounts carried forward,	$120,080 71	$215,275 60

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1910.	
Amounts brought forward,	$120,080 71	$215,275 60
Distribution Department — *Concluded.*		
Weston Reservoir,	2,347 19	
Spot Pond,	7,219 36	
Buildings at Spot Pond,	123 00	
Pipe lines: —		
Low service,	46,149 17	
Northern high service,	2,647 13	
Southern high service,	4,336 02	
Supply pipe lines,	559 37	
Buildings at Chestnut Hill Reservoir,	493 30	
Chestnut Hill pipe yard,	1,054 33	
Glenwood pipe yard and buildings,	4,033 83	
Stables,	6,361 54	
Venturi meters,	1,635 11	
Measurement of water,	1,448 93	
Arlington pumping station, buildings and grounds,	356 93	
		198,845 92
Total for maintaining and operating works,	. . .	$414,121 52

(7) DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1910.

(*a*) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1910, and ending December 31, 1910, is $502,624.92, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1910, is $41,546,929.56.

For maintenance and operation the expenditures for the year have been $414,121.52, and from the beginning of the work, $4,225,168.78.

The salaries of the commissioners, and other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character: —

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.				
Administration.				
Commissioners,	$2,333 34		$120,810 25	
Secretary and auditor,	750 00		50,592 03	
Clerks and stenographers,	1,658 68		62,632 84	
Legal services,	-		2,359 00	
Traveling,	13 68		3,674 57	
Stationery and printing,	1,512 85		13,248 02	
Postage, express and telegrams,	-		2,917 17	
Furniture and fixtures,	5 50		4,288 64	
Alterations and repairs of buildings,	80		5,790 97	
Telephone, lighting, heating, water and care of building,	232 26		11,929 34	
Rent and taxes, main office,	438 59		5,621 49	
Miscellaneous expenses,	54 08		4,588 75	
		$6,999 78		$288,453 07
Engineering.				
Chief engineer and department engineers,	-		$207,471 36	
Principal assistant engineers,	$3,102 88		161,114 18	
Engineering assistants,	7,978 67		1,045,992 89	
Consulting engineers,	1,200 00		25,615 07	
Inspectors,	7,710 54		303,471 05	
Architects,	-		36,161 19	
Railroad and street car travel,	694 51		27,579 13	
Wagon hire,	-		45,337 53	
Stationery and printing,	334 21		26,753 08	
Postage, express and telegrams,	-		7,730 00	
Engineering and drafting instruments and tools,	-		19,309 53	
Engineering and drafting supplies,	29 23		25,019 51	
Books, maps and photographic supplies,	60 71		7,049 93	
Furniture and fixtures,	-		14,978 46	
Alterations and repairs of buildings: —				
Main office,	34		14,109 30	
Sub-offices,	-		2,939 36	
Telephone, lighting, heating, water and care of buildings: —				
Main office,	696 81		26,454 47	
Sub-offices,	-		19,667 82	
Rent and taxes, main office,	1,315 80		16,632 95	
Rent of sub-offices and other buildings,	-		4,526 74	
Field offices and sheds,	-		1,274 49	
Clinton office building,	-		9,866 87	
Unclassified supplies,	13 65		8,264 87	
Miscellaneous expenses,	47 76		8,992 75	
		23,185 11		2,066,312 53
Amounts carried forward,	. . .	$30,184 89		$2,354,765 60

General Character of Expenditures.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
Amounts brought forward,		$30,184 89		$2,354,765 60
Construction.				
Preliminary work (borings, test pits and other investigations): —				
Advertising,	$202 98		$6,661 89	
Other preliminary work as given in detail in preceding annual report,	-		155,457 41	
		202 98		162,119 30
Contracts, Wachusett Reservoir: —				
Contracts completed and final payments made prior to January 1, 1910,	-		$5,406,738 30	
McBride & Co., Stillwater improvement,	-		23,314 67	
Sundry bills paid under this contract,	-		3,552 11	
		-		5,433,605 08
Contracts completed, improving Wachusett Watershed,		-		11,893 75
Contracts completed, Wachusett Aqueduct,		-		1,447,208 55
Contracts completed, Sudbury Reservoir,		-		1,545,028 33
Contracts completed, protection Sudbury supply,		-		9,000 00
Contracts completed, improving Lake Cochituate,		-		60,657 45
Contracts completed, protection Cochituate supply,		-		9,000 00
Contracts completed, Rosemary siphon,		-		5,916 96
Contracts completed, pipe line, Dam No. 3 to Dam No. 1,		-		17,240 22
Contracts completed, Clinton sewerage system,		-		66,878 22
Contracts, Weston Aqueduct: —				
Contracts completed and final payments made prior to January 1, 1910,		-		2,376,004 54
Contracts, Distribution System: —				
Contracts completed and final payments made prior to January 1, 1910,	-		$4,659,060 73	
Coffin Valve Co., water valves,	$8,607 00		8,607 00	
Florence Iron Works, 60-inch cast-iron water pipes,	62,086 55		100,549 39	
Standard Cast Iron Pipe and Foundry Co., special castings,	5,361 45		8,757 20	
Standard Cast Iron Pipe and Foundry Co., special castings,	5,767 10		5,767 10	
U. S. Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings,	41,998 92		100,603 19	
U. S. Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings,	4,444 71		4,444 71	
U. S. Cast Iron Pipe and Foundry Co., cast-iron water pipes,	5,249 07		5,249 07	
Amounts carried forward,	$133,514 80	$30,387 87	$4,893,038 39	$13,499,318 00

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
Amounts brought forward,	$133,514 80	$30,387 87	$4,893,038 39	$18,499,318 00
Construction — Con.				
Contracts, Distribution System — *Concluded.*				
U. S. Cast Iron Pipe and Foundry Co., cast-iron water pipes,	36,831 30		36,831 30	
U. S. Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings,	3,932 64		3,932 64	
Warren Foundry and Machine Co., cast-iron pipes and special castings,	4,769 04		4,769 04	
Warren Foundry and Machine Co., cast-iron pipes and special castings,	2,191 18		2,191 18	
Camoia & Williams, laying water pipes on Sect. 33,	1,787 20		14,231 98	
Chas. M. Callahan, laying water pipes on Sect. 35 of northern extra high-service pipe lines,	4,292 38		4,292 38	
Devincenzi & Baruffoldi, laying water pipes on Sect. 36 of northern extra high-service pipe lines,	3,233 31		3,233 31	
Chas. J. Jacobs Co., laying water pipes on Sect. 8 of Weston Aqueduct supply mains,	19,546 64		40,525 39	
Joseph Hanreddy, laying water pipes on Sect. 7 of Weston Aqueduct supply mains,	52,300 19		52,300 19	
Cavanagh Bros., laying water pipes on Sect. 6 of Weston Aqueduct supply mains,	36,661 10		36,661 10	
Michael Russo, laying water pipes on Sect. 37 of low-service pipe lines,	11,823 18		11,823 18	
Holly Manufacturing Co., furnishing and erecting pumping engine at the Chestnut Hill high-service pumping station,	50,000 00		50,000 00	
Standard Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings,	3,609 61		3,609 61	
		364,492 57	$5,157,439 69	
Deduct value of pipes, valves, etc., included in above list, transferred to maintenance account December 31, 1900,	-		3,139 77	
				5,154,299 92
Additional work: —				
Labor,	$28,205 07		$796,606 72	
Professional services, medical services, analyses, etc.,	1,698 00		3,680 99	
Traveling,	70		2,747 80	
Rent,	375 00		4,077 22	
Water rates,	-		1,454 77	
Freight and express,	393 25		13,862 57	
Jobbing and repairing,	247 90		9,946 08	
Tools, machinery, appliances and hardware supplies,	5,905 72		84,243 97	
Electrical supplies,	185 30		5,563 93	
Amounts carried forward,	$37,010 94	$394,880 44	$922,184 05	$18,653,617 92

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
Amounts brought forward,	$37,010 94	$394,880 44	$922,184 05	$18,653,617 92
Construction — Con.				
Additional work — *Con.*				
Castings, ironwork and metals,	3,552 99		87,259 03	
Iron pipe and valves,	13,709 23		75,762 40	
Blasting supplies,	5 27		1,950 15	
Paint and coating,	125 93		4,599 46	
Fuel, oil and waste,	1,624 82		12,178 12	
Lumber and field buildings,	2,817 10		90,011 88	
Drain pipe,	72 00		9,235 80	
Brick, cement and stone,	4,439 23		31,497 95	
Sand, gravel and filling,	663 69		7,603 35	
Municipal and corporation work,	5,592 68		220,664 67	
Police service,	-		210,801 74	
Sanitary inspection,	-		13,107 09	
Judgments and settlements for damages,	-		53,124 26	
Unclassified supplies,	266 78		17,978 30	
Miscellaneous expenses,	85 78		6,154 25	
		69,966 44		1,764,112 50
Legal and expert: —				
Legal services,	-		$4,668 82	
Expert services,	-		1,862 66	
Court expenses,	-		1,317 20	
Miscellaneous expenses,	-		185 80	
		-		8,034 46
Real Estate.				
Legal and expert: —				
Legal services,	-		$4,736 31	
Conveyancer and assistants,	$262 00		110,644 97	
Experts,	137 35		18,008 93	
Appraisers,	-		22,332 75	
Court expenses,	-		11,139 43	
Counsel expenses,	-		43 25	
Conveyancing supplies,	6 00		3,190 53	
Conveyancing expenses,	40 40		5,977 94	
Miscellaneous expenses,	-		4,326 15	
Settlements made by Board,	37,052 23		3,428,365 07	
Judgments,	270 61		170,716 24	
Taxes and tax equivalents,	-		68,182 41	
Care and disposal,	9 45		86,901 14	
		37,778 04		3,934,565 12
Damages to Real Estate not taken, to Business and on Account of Loss of Wages.				
Legal and expert: —				
Legal services,	-		$1,130 67	
Expert services,	-		2,857 62	
Court expenses,	-		15,394 34	
Amounts carried forward,	-	$502,624 92	$19,382 63	$24,360,330 02

General Character of Expenditures.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
Amounts brought forward,	-	$502,624 92	$19,382 63	$24,360,330 02
Damages to Real Estate not taken, to Business and on Account of Loss of Wages — Con.				
Legal and expert — *Con.*				
Miscellaneous expenses,	-		125 00	
Settlements,	-		415,513 65	
Judgments,	-		116,733 42	
		-		551,754 70
Claims on Account of Diversion of Water.				
Legal and expert: —				
Legal services,	-		$3,774 98	
Expert services,	-		19,339 69	
Court expenses,	-		20,775 49	
Miscellaneous expenses,	-		1,289 58	
Settlements,	-		917,350 00	
Judgments,	-		220,969 67	
		-		1,183,499 41
Purchase of Existing Water Works.				
Legal and expert: —				
Legal services,	-		$1,878 89	
Expert services,	-		13,569 82	
Court expenses,	-		29,728 38	
Miscellaneous expenses,	-		1,470 94	
Settlements and judgments,	-		15,227,100 01	
		-		15,273,748 04
Relocation Central Massachusetts Railroad.				
Settlements,		-		177,597 39
Total amount of construction expenditures,		$502,624 92		$41,546,929 56

General Character of Expenditures.	For the Year ending December 31, 1910.
Maintenance and Operation of Works.	
Administration: —	
Commissioners,	$5,833 33
Secretary and assistants,	6,173 66
Rent,	333 32
Repairs of building,	204 52
Fuel,	19 73
Lighting,	82 93
Care of building,	389 01
Postage,	36 00
Amount carried forward,	$13,072 50

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.	
Amount brought forward,	$13,072 50	
MAINTENANCE AND OPERATION OF WORKS — *Con.*		
Administration — *Con.*		
Printing, stationery and office supplies,	409 12	
Telephones,	217 18	
Traveling expenses,	55 27	
Miscellaneous expenses,	37 74	
		$13,791 81
General supervision: —		
Chief engineer and assistants,	$24,975 63	
Rent,	1,000 00	
Repairs of building,	833 34	
Fuel,	59 18	
Lighting,	250 75	
Care of building,	1,167 20	
Postage,	119 00	
Printing, stationery and office supplies,	814 55	
Telephones,	740 09	
Traveling expenses,	409 55	
Miscellaneous expenses,	926 74	
		31,296 03
Pumping service: —		
Labor,	$61,933 82	
Fuel,	34,332 78	
Oil, waste and packing,	1,398 44	
Repairs,	1,465 59	
Small supplies,	1,274 17	
Rent, West Roxbury pumping station,	786 53	
		101,191 33
Reservoirs, aqueducts, pipe lines, buildings and grounds: —		
Superintendents,	$6,600 00	
Engineering assistants,	9,259 65	
Sanitary inspectors,	3,651 65	
Labor, pay roll,	125,580 59	
Labor, miscellaneous,	1,831 92	
Alterations and repairs of pumping stations,	79 91	
Alterations and repairs of other buildings and structures,	792 70	
Automobiles,	4,850 66	
Brick,	65 50	
Brooms, brushes and janitor's supplies,	144 79	
Castings, ironwork and metals,	955 65	
Cement and lime,	489 02	
Drafting and photo supplies,	100 12	
Fertilizer and planting material,	455 96	
Freight and express,	510 51	
Fuel,	3,257 89	
Amounts carried forward,	$158,626 52	$146,279 17

General Character of Expenditures.	For the Year ending December 31, 1910.	
Amounts brought forward,	$158,626 52	$146,279 17
Maintenance and Operation of Works — *Con.*		
Reservoirs, aqueducts, pipe lines, buildings and grounds — *Con.*		
Gypsy moth supplies,	684 46	
Hardware,	709 84	
Hay and grain,	2,113 86	
Horses,	543 50	
Lighting,	393 97	
Lumber,	1,738 73	
Machinery,	67 10	
Paints and oils,	1,077 63	
Pipe and fittings,	11,080 99	
Postage,	124 73	
Printing, stationery and office supplies,	647 98	
Rubber and oiled goods,	319 60	
Stable expenses,	844 90	
Sand, gravel and stone,	84 46	
Traveling expenses,	2,286 54	
Telephones,	930 41	
Teaming,	1,202 25	
Tools and appliances,	958 28	
Vehicles, harnesses and fittings,	409 09	
Municipal and corporation work,	135 83	
Miscellaneous expenses,	21,377 55	
Contracts: —		
Henry Spinach Contracting Co., contract 19-M, improvement of Lake Cochituate (surface-water drains in Framingham, Natick and Wayland),	25,712 09	
		232,070 31
Payments in lieu of taxes,		35,772 04
Total expenditures for maintenance and operation,		$414,121 52

(*b*) *Receipts.*

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1910, and ending December 31, 1910, is $62,379.24, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1910, is $714,973.06. The general character of these receipts is as follows: —

General Character of Receipts.	For the Year ending December 31, 1910.		From Beginning of Wor to December 31, 1910.	
For distribution back to District: —				
Fees for admission to District,	-		$92,265 00	
Water furnished to cities and towns outside of District,	-		90,454 77	
Water furnished to water companies,	-		37,145 88	
		-		$219,865 65
To the credit of the loan fund: —				
Real estate and buildings,	$5,991 32		$44,039 34	
Tools, supplies and reimbursements,	25,511 06		154,534 70	
District entrance fees (Swampscott),	-		90,000 00	
		$31,502 38		288,574 04
To the credit of the maintenance fund: —				
Tools, supplies and reimbursements,	$19,550 33		$26,776 07	
		19,550 33		26,776 07
To the credit of the sinking fund: —				
Water furnished to cities and towns outside of District and to water companies,	$3,947 54		$20,798 75	
Forfeiture for contracts awarded but not executed,	-		500 00	
Rents,	1,633 41		94,072 78	
Land products,	5,544 58		60,926 86	
Unclassified receipts and interest,	201 00		3,458 91	
		11,326 53		179,757 30
Total receipts,	. . .	$62,379 24		$714,973 06

The foregoing receipts have been credited to the various objects or works, as follows: —

Sources of Receipts.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
Admission into Metropolitan Water District (Quincy, Nahant, Arlington, Stoneham, Milton, Lexington and Swampscott),	-		$182,265 00	
Supplying water to cities and towns outside of Water District (Swampscott, Revere, Lexington, Wakefield, Cambridge, Framingham and U. S. Government), and to water companies (Framingham, Milton and Revere),	$3,947 54		148,399 40	
		$3,947 54		$330,664 40
Construction and acquisition of works: —				
Administration,	$41 11		$285 06	
Wachusett Dam,	152 77		6,912 25	
Amounts carried forward,	$193 88	$3,947 54	$7,197 31	$330,664 40

SOURCES OF RECEIPTS.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
Amounts brought forward,	$193 88	$3,947 54	$7,197 31	$330,664 40
Construction and acquisition of works — *Con.*				
Wachusett Reservoir,	4,367 30		140,042 17	
Wachusett Aqueduct,	-		5,204 70	
Weston Aqueduct,	62 50		5,200 13	
Sudbury Reservoir,	25 00		10,640 42	
Distribution system,	26,982 31		101,340 59	
Diversion of water, Clinton sewerage system,	-		1,367 94	
Purchase of existing water works,	-		18,119 08	
		31,630 99		289,112 34
Maintenance and operation of works: —				
Administration,	$102 83		$221 39	
General supervision,	450 00		1,252 76	
Wachusett Aqueduct,	293 71		4,973 78	
Wachusett Reservoir,	5,132 10		33,118 67	
Sudbury system,	2,221 09		17,684 47	
Distribution system,	18,136 93		32,602 46	
Clinton sewerage system,	464 05		5,342 79	
		26,800 71		95,196 32
Total receipts,		$62,379 24		$714,973 06

(*c*) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate and buildings connected therewith.

(*d*) *Liabilities.*

The sums due on monthly pay rolls amount to $1,594.72, and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

Name.	Work.	Amount.
McBride & Co.,	Contract 283, Stillwater improvement, Wachusett Reservoir.	$778 09[1]
Camois & Williams,	Contract 308, Section 33 of northern high-service pipe lines, Distribution System.	689 29
Chas. M. Callahan,	Contract 316, Section 35 of northern high-service pipe lines, Distribution System.	225 92
Devincenzi & Baruffoldi,	Contract 322, Section 36 of northern extra high-service pipe lines, Distribution System.	100 00
Joseph Hanreddy,	Contract 314, Section 7 of the Weston Aqueduct supply mains.	9,052 97
Cavanagh Bros.,	Contract 323, Section 6 of the Weston Aqueduct supply mains.	4,116 67
Michael Russo,	Contract 326, Section 37 of low-service pipe lines, Distribution System.	1,262 92
Standard Cast Iron Pipe and Foundry Company.	Contract 325, cast-iron pipes and special castings.	636 99
The Henry Spinach Contracting Company,	Contract 19-M, improving Lake Cochituate,	4,537 43
Holly Manufacturing Company,	Contract 312, pumping engine for Chestnut Hill low-service pumping station.	49,769 00

[1] Held pending settlement of claims on account of this contract.

It is impossible to state the amounts due on the claims of the following for land damages, for water rights taken and for damages to established business, as no sums have been agreed upon, and suits are now pending in court for the determination of most of them: —

Patrick Bradley, Henry F. Keyes, James E. Welch, Byron D. Allen, J. Frank Wood *et al.*, Asa Knight, Edward F. Merriam, Sanford C. Kendall, estate of William H. Vickery, James H. and Hannah S. Wood, Francis W. M. Goodale, heirs of Willard Morse, Caroline R. Braman, Charles G. Rice, Nehemiah W. Rice *et al.*, John Ward *et al.*, heirs of George K. Ward, heirs of Francis Pettee, William F. Harbach *et al.*, Fannie M. Flemming, Royal S. Wentworth *et al.*, trustees.

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan Sewerage District embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville and Woburn, and the towns of Arlington, Belmont, Revere, Stoneham, Wakefield, Winchester and Winthrop, and parts of the city of Boston and the town of Lexington, — comprising in all 9 cities and 8 towns. The district has an area of 90.50 square miles, with an estimated population, based upon the United States Census of 1910, as of December 31, 1910, of 534,217. Of the total population it is estimated that 87.1 per cent., or 465,302 people, contribute sewage to the North Metropolitan System. The sum of $209,065.54 has been expended on account of construction during the past year. The total cost of the North Metropolitan Sewerage Works has been $6,521,196.15.

The South Metropolitan Sewerage District includes the cities of Newton, Quincy and Waltham, and the towns of Brookline, Hyde Park, Milton and Watertown, and parts of the city of Boston and the town of Dedham, — a total of 4 cities and 5 towns. This district has an area of 100.87 square miles, with an estimated population as of December 31, 1910, of 359,670. According to the estimates made 64 per cent. of this population, or 230,365, contribute sewage to the South Metropolitan System. The sum of $7,481.84 has been expended on account of construction during the past year. The total expenditures for construction of the South Metropolitan Sewerage Works have amounted to $8,792,779.64.

Chapter 546 of the Acts of the Legislature of 1910 added the territory comprising the town of Braintree to the South Metropolitan District. This Act, however, was to take effect only when accepted by a majority of the legal voters of the town of Braintree present and voting thereon at a meeting legally called for the purpose. No action under the Act was taken by the town during the year.

(1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

(a) *Deer Island Pumping Station Extension.*

The work of extending the Deer Island pumping station and of installing a new pumping engine, with boilers and other apparatus, has been continued during the year and brought substantially to completion. The addition to the pumping station was 50 feet long and 45 feet, 8 inches wide, and there has been added a new coal house having a length of 103 feet and a width of 35 feet. These buildings have been erected so as to harmonize in general with the old station. There has been installed in the house a new pumping engine constructed by the Allis-Chalmers Company, having a capacity for pumping 100,000,000 gallons of sewage per day, with a lift of 19 feet. The engine was put into operation in the month of April. The operation of the engine and pumps in the ordinary working service of the station has been satisfactory, and the test which has been made has shown an efficiency and duty considerably in advance of the stipulations made in the contract. The sum of $177,707.76 has been expended, $101,631.68 in connection with the building and $76,076.08 for the pumping plant. The entire expense will come within the original appropriation of $195,000.

(*b*) *East Boston Pumping Station Extension.*

Work has been continued during the year in completing the repairs to the East Boston pumping station, which was partially burned at the Chelsea fire, and in erecting the additions to the station and new coal house which had been contemplated. A pile wharf has been built in connection with the coal house, and this is to be made so far as possible fireproof. The parts of the new pumping engine to be furnished by the Allis-Chalmers Company have been delivered and are now in process of being set up. Boilers and other accessories have already been erected, and it is expected that the engine will be in condition to be put into operation in the first half of the coming year. The sum of $160,175.85 has been expended on account of the extensions and pumping plant at this station. The cost of the repairs and renewals of the East Boston station, made necessary on account of the Chelsea fire, which will be chargeable to maintenance, has amounted to $39,150.57, leaving a small balance from the total special appropriation of $40,000.

(*c*) *East Boston Stable and Locker Building.*

A beginning has been made in the erection of a building for stable and locker purposes on the lot between Chelsea Street and the Grand Junction Railroad, near the East Boston pumping station, recently purchased in place of the old stable and locker lot, and the structure has been about half completed. The building and grounds will be made ready for occupancy during the coming season.

(2) SOUTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

Quincy Sewage Lift.

In accordance with the requirement of the original High-level Sewer Act, that the Metropolitan Sewerage Commission should build and operate such force mains and pumping stations as might be necessary to drain the sewerage system of the city of Quincy into the High-level Sewer, the Board was called upon by that city to provide for the lifting of the sewage of the low district, comprising the easterly and southerly portions of Hough's Neck, into the main sewer.

The Board has, therefore, under the authority of chapter 292 of the Acts of 1910, proceeded to the erection of a small building on Island Avenue, about half a mile distant from the Nut Island screen-house, near which is built a storage well, and in which is also installed an automatic lift, to be operated by electricity generated at the Nut Island screen-house, from which the working of the lift is regulated. Two pumps, having each a daily capacity of 1,500,000 gallons, have been installed. The lift will be ready for operation early in the coming year.

(3) ACQUISITION OF LAND AND SETTLEMENTS.

The Board acquired during the year, by purchase, about 9,708 square feet of land on Chelsea Street and Chelsea Creek in East Boston, near the East Boston sewerage pumping station, for the purposes of a stable and locker building, for which the sum of $4,463.40 was paid. A taking also of the parcel was afterwards made.

A settlement was also effected for an easement in 0.019 of an acre of land in Brookline, previously taken for the construction of the High-level Sewer, in which the sum of $192.87 was paid.

Taking for Metropolitan Sewerage Works for the Year 1910.

No.	LOCATION AND DESCRIPTION.	Former Owner.	Recorded.	Purpose of Taking.
24	East Boston, — on Addison Street and Boston & Albany Railroad. Area, fee in 9,708 square feet. Also rights of way in street and railroad location.	East Boston Company.	1910. Apr. 22.	For stable and locker building.

(4) NORTH METROPOLITAN SYSTEM — MAINTENANCE.

The cost of maintenance of the North Metropolitan System during the past year has been $148,991. In addition to this, $11,760 was expended in the repairs on the East Boston station from the special appropriation of $40,000.

(a) *Sewers and Pumping Stations.*

The length of the sewers on the North Metropolitan System is 58.57 miles, and the Metropolitan sewers with connections with local sewers have a combined length of 669.07 miles, involving 69,443 connections.

The sewage before it is finally disposed of in the harbor off Deer Island is lifted, the most of it at least twice and a portion three times, by pumping at the four stations, the Alewife Brook, Charlestown, East Boston and Deer Island pumping stations.

The daily average amount of sewage discharged into the harbor from the Deer Island outlet was 59,000,000 gallons, which was a daily average for each individual of the population contributing sewage of 126.8 gallons. This daily average is made larger from the fact that a considerable number of the local sewers permit the direct introduction of rain water. The total amount of the discharge is 1,600,000 gallons per day less than that of the preceding year, a decrease which is accounted for by the scarcity of the rainfall. The maximum amount of sewage discharged in any one day in the year was 135,100,000 gallons.

The pumping stations operated for the North Metropolitan Sewerage System are as follows: —

	No. of Engines.	Maximum Contract Capacity per Day (Gallons).	Lift (Feet).
Deer Island Station,	4	300,000,000	19
East Boston Station,[1]	3	165,000,000	19
Charlestown Station,	3	160,000,000	11 8
Alewife Brook Station,	3	23,000,000	13

[1] The new pumping engine in process of erection for the East Boston pumping station will have a maximum contract capacity of 100,000,000 gallons, and a lift of 19 feet.

There were consumed for the operation of the pumping stations 7,329.21 tons of bituminous coal, which was purchased at average prices at the different stations varying from $3.72 to $4.38 per gross ton delivered in the bins.

The sums expended for the labor of engineers and their assistants in the various pumping stations of the district amounted to $55,754.93.

The average cost per million gallons of sewage per foot lifted at the several stations was $0.122.

(*b*) *Siphons and Relocation of Sewers.*

The siphons which were required to be introduced in the main sewer crossing the Alewife Brook in Arlington, in order to conform to the improvements made by the Metropolitan Park Commission, were substantially completed in the previous year, but were put into operation at the beginning of the past year. The cost of the changes made was $2,634.27, and this sum was repaid by the Park Commission.

The siphon which was made necessary in the Metropolitan sewer in Cambridge, at Portland Street, by the building of the subway by the Boston Elevated Railway Company, was completed early in the year and put into operation. The introduction of this siphon requires the cleaning and flushing of the sewer as often as twice in each week by a gang of sewer men, causing a very considerable increase in the annual expenses of the District for maintenance. The construction of the subway also compelled a relocation of the Metropolitan sewer, originally built in Eliot Street and Eliot Square, by a detour into Murray Street. The old sewer was abandoned for a distance of 470 feet and its place was supplied by 660 feet of new sewer and iron pipes. By this relocation the introduction of another siphon was avoided. The necessary work involved was performed at both points by the Railway Company, at an approximate cost of $29,000.

(*c*) *Tanneries and Gelatine and Glue Works.*

The quantity and character of the matter discharged into the Metropolitan sewers from the tanneries and the gelatine and glue works in the city of Woburn and the towns of Winchester and Stoneham have called for the serious attention of the Board.

Complaints have been made in the past of overflows from manholes occurring in some instances during periods of heavy rain, from the Mystic Valley main sewer which receives the sewage of the city of Woburn and the town of Winchester. Careful investigations have been made with the view to ascertain whether this sewer had so nearly reached the proper limit of its capacity that the time had come to call for the construction of a supplementary main sewer for this district.

Upon the construction of the North Metropolitan Sewerage System the lower portion of the old Mystic Valley sewer, built by the city of Boston for the protection of the Mystic water supply, was taken to form a part of the Metropolitan System. The upper portion of the old sewer running through the town of Winchester and into the city of Woburn still remained the property of the city of Boston, and was subsequently taken over by the Board in connection with the city's water works. The manufacturing establishments were still permitted to use the upper part of the old sewer, under protective restrictions, for the discharge of their sewage and wastes into the Metropolitan System.

The investigations showed that these establishments had begun to neglect the restrictions which had been long before observed, and were emptying into this sewer great quantities of objectionable manufacturing wastes which were passing down and entering the Metropolitan sewer below. The wastes were of such a glutinous character as to clog the sewers, and, in fact, seriously to diminish their actual capacities for the carrying of sewage. The proprietors of the establishments were called upon to abide by the restrictions formerly made, and to provide settling tanks which should receive and collect the objectionable substances before any discharge from the works should enter the sewer. The municipal authorities were also notified that, unless the directions of the Board were observed, discharge into the Metropolitan sewers from the offending establishments would not be permitted.

After considerable delay on the part of some of the proprietors the Board's requirements have been complied with, and except in two cases settling tanks have been built and put in operation. In the two excepted cases the tanks are in process of construction.

It is still a question, independent of the admission of objectionable waste, whether the great quantities of liquids coming from these establishments should continue to be discharged into the Metropolitan System, which was intended for the disposal of sewage only.

The measures which have been taken will much improve the situation which has been complained of, and it is possible that by the observance of proper regulations the necessity for further and expensive sewer construction for the Mystic Valley will be deferred for a considerable period.

(5) SOUTH METROPOLITAN SEWERAGE SYSTEM — MAINTENANCE.

The entire cost of maintenance during the past year has been $101,781.68.

Sewers and Pumping Stations.

The Metropolitan sewers in the South Metropolitan System have a length of 43.42 miles, and with these are connected local sewers having a length of 542.25 miles, requiring 148 connections.

The pumping stations operated for the South Metropolitan Sewerage System are as follows: —

	No. of Engines.	Maximum Contract Capacity per Day (Gallons).	Lift (Feet).
Ward Street Station,	2	100,000,000	45
Quincy Station,	3	18,000,000	28

The larger part of the sewage of the District is lifted into the High-level Sewer at the Ward Street pumping station in Roxbury, but the sewage of the city of Quincy is pumped into the sewer at Greenleaf Street near the Quincy pumping station. The entire sewage is screened at the Nut Island screen-house, and thence discharged at the bottom of the harbor about a mile off from the Island.

The average daily amount of the sewage thus discharged was 39,600,000 gallons, and the largest discharge in a single day was 141,000,000 gallons. The decrease in the daily average discharge from last year was 800,000 gallons.

The daily average discharge of sewage for each individual contributing sewage in the District was 171.9 gallons. The decrease from last year of 1.47 gallons was principally owing to the lack of heavy rains.

There were 2,810.81 gross tons of bituminous coal consumed at the two pumping stations and screen-house, which was purchased at average prices varying from $3.98 to $4.21 per gross ton delivered in the bins.

The expenditures for the labor of the engineers and their assistants at the three stations amounted to $31,849.69.

VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with the thirtieth day of November, 1910, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906 and a copy of this financial abstract is in part printed as Appendix No. 5.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1910, is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan Sewerage Loans authorized for the construction of the Sewerage Works of the North Metropolitan System have amounted to $6,573,865.73, to which are added receipts from various sources amounting to $63,391.78. The amount of expenditures approved by the Board for payment for the year 1910 was $209,065.54, and the total amount of expenditures approved to January 1, 1911, was $6,521,196.15. The balance remaining on January 1, 1911, was $116,061.36.

The loans authorized for the construction of the various parts of the South Metropolitan System have amounted to $8,867,046.27. The receipts applicable to the loan fund have been $13,401.13. The amount of expenditures approved for payment in the year 1910 was $7,481.84. The total amount of expenditures approved for payment from the beginning of the works has been $8,792,779.64. The balance remaining for the South Metropolitan System on January 1, 1911, was $87,667.76.

The bonds issued on account of the loans have been for varying periods, not exceeding forty years, and bear interest at the rate of 3 per cent. and 3½ per cent. The premiums received on account of the sale of bonds for the North Metropolitan System have amounted to $179,547.35, and those received on account of the South Metropolitan System have amounted to $410,132.03.

The increase in the debt during the calendar year, as represented by the Metropolitan Sewerage Loans, was $113,000. The increase of the sinking fund for the payment of the debt at maturity was, during the same period, $257,957.49. There has consequently been a decrease in the net debt during the calendar year amounting to $144,957.49.

The amount expended for maintenance of the North Metropolitan System in the year 1910 was $160,751, and for the South Metropolitan System $101,781.68, a total for both systems of $262,532.68.

The assessments made to meet interest, sinking fund requirements and maintenance and operation of the North Metropolitan System amounted in the year 1910 to $442,376.41, and the assessments for the South Metropolitan System amounted to $457,071.75.

The following is a detailed financial statement regarding the Metropolitan Sewerage Works: —

(1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, and the expenditures for construction, have been as follows: —

(*a*) *North Metropolitan System.*

Loans authorized under the various acts, including those for the Revere, Belmont and Malden extensions and North System enlargement and extension, ...		$6,573,865 73
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System: —		
For the year ending December 31, 1910, .	$254 59[1]	
For the period prior to January 1, 1910, .	63,137 19[1]	
		63,391 78
		$6,637,257 51
Amount approved for payment by the Board[2] out of the Metropolitan Sewerage Loan Fund, North System: —		
For the year ending December 31, 1910, .	$209,065 54	
For the period prior to January 1, 1910,	6,312,130 61	
		6,521,196 15
Balance, North Metropolitan System, January 1, 1911, .		$116,061 36

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[1] Of these amounts ($180.60 for the year 1910), a total of $16,960.61 was received directly by the State Treasurer and credited to this fund and not on our books until December, 1910.

[2] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

(*b*) *South Metropolitan System.*

Loans authorized under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension,			$8,867,046 27
Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —			
For the year ending December 31, 1910,			1,994 31
For the period prior to January 1, 1910,			11,406 82
			$8,880,447 40
Amount approved by the Board[1] for payment out of the Metropolitan Sewerage Loan Fund, South System: —			
On account of the Charles River valley sewer,		$800,046 27	
On account of the Neponset valley sewer,		911,531 46	
On account of the High-level sewer and extension: —			
For the year ending December 31, 1910,	$7,481 84		
For the period prior to January 1, 1910,	7,073,720 07		
		7,081,201 91	
			8,792,779 64
Balance, South Metropolitan System, January 1, 1911,			$87,667 76

(2) Issues of Metropolitan Sewerage Loan Bonds.

The Treasurer of the Commonwealth, under the authority of the successive statutes, has from time to time issued bonds designated "Metropolitan Sewerage Loan," amounting for the North System to $6,563,000, and for the South System to $8,877,912. The list of the bonds issued prior to the year 1910 is contained in the last (Ninth) Annual Report. The bonds issued in the year 1910 are as follows: —

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[1] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

Date of Sale.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
Feb., 1910, ...	$113,000	3½	100.39	Jan. 1, 1950	$440 70

(3) Metropolitan Sewerage Loans Sinking Fund.

Under the authority of chapter 122 of the Acts of the year 1899 the Treasurer and Receiver-General of the Commonwealth was required to consolidate the sinking funds of all the Metropolitan Sewerage Loans into one fund, to be known as the Metropolitan Sewerage Loans Sinking Fund.

The Board received during the year, from rentals and from other sources, to be applied to the sinking fund, $182.19.

The sinking fund established has amounted at the end of each year to sums as follows: —

December 31, 1899, .	$361,416 59	December 31, 1905, .	$1,008,724 95
December 31, 1900, .	454,520 57	December 31, 1906, .	1,146,998 68
December 31, 1901, .	545,668 26	December 31, 1907, .	1,306,850 30
December 31, 1902, .	636,084 04	December 31, 1908, .	1,492,418 98
December 31, 1903, .	754,690 41	December 31, 1909, .	1,673,784 40
December 31, 1904, .	878,557 12	December 31, 1910, .	1,931,741 89

(4) Annual Appropriations, Receipts and Expenditures.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1910, have been as follows: —

North Metropolitan System.

Appropriation under chapter 388 of the Acts of 1910, . .	$149,000 00
Balance of appropriation under chapter 582 of the Acts of 1908, ...	12,609 43
Receipts from pumping and from other sources, . . .	3,081 59
	$164,691 02
Amount approved by the Board for payment, ...	160,751 00
Balance, January 1, 1911, ...	$3,940 02[1]

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[1] Of this balance, $849.48 is the remaining portion of the special appropriation of $40,000 made by chapter 582 of the Acts of 1908, for the restoration and equipment of the East Boston pumping station, on account of the Chelsea fire of April 12, 1908.

South Metropolitan System.

Appropriation under chapter 340 of the Acts of 1910, . . .	$103,200 00
Receipts from pumping and from other sources, . . .	253 50
	$103,453 50
Amount approved by the Board for payment, ...	101,781 68
Balance, January 1, 1911, ...	$1,671 82

(5) Annual Assessments.

Assessments for the year, amounting to $442,376.41, for the North Metropolitan System and to $457,071.75 for the South Metropolitan System, were required for the payment of interest and sinking fund requirements and the cost of maintenance and operation of works. The requirements for the North Metropolitan System were: for interest, $192,230.07; for the sinking fund, $108,827.97; and for maintenance, $141,318.37. For the South Metropolitan System the requirements were: for interest, $297,553.23; for the sinking fund, $66,097.39; and for maintenance, $93,421.13. The assessments for the North Metropolitan System were made upon the cities and towns in the District in accordance with chapter 369 of the Acts of the year 1906. Assessments for the South Metropolitan System were likewise made in accordance with said chapter, the period of five years for which apportionment was made under decree of the Supreme Judicial Court in the year 1905 having expired with the preceding year. The respective assessments were as follows: —

North Metropolitan Sewerage System.

Arlington, . . .	$10,319 02	Revere, . . .	$13,481 40
Belmont, . . .	5,545 04	Somerville, . . .	61,151 21
Boston, . . .	74,329 82	Stoneham, . . .	5,084 89
Cambridge, . . .	99,695 56	Wakefield, . . .	9,057 67
Chelsea, . . .	26,911 34	Winchester, . . .	11,008 98
Everett, . . .	25,610 54	Winthrop, . . .	9,662 19
Lexington, . . .	4,066 79	Woburn, . . .	11,505 50
Malden, . . .	39,209 87		
Medford, . . .	20,901 64	Total, . . .	$442,376 41
Melrose, . . .	14,834 95		

South Metropolitan Sewerage System.

Boston,	$195,328 79	Quincy,	$28,372 01
Brookline,	83,289 83	Waltham,	26,502 34
Dedham,	11,219 96	Watertown,	13,430 95
Hyde Park,	14,148 98		
Milton,	21,468 88	Total,	$457,071 75
Newton,	63,310 01		

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works: —

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
North Metropolitan System.				
Original system, main line and branches,		-		$5,383,957 67
Lexington branch,		-		68,585 15
Everett branch,		-		54,877 12
Wakefield branch,		-		35,698 29
Stoneham branch,		-		11,574 10
Revere extension,		-		215,722 79
Chelsea and Everett outlets,		-		71,216 41
Wakefield branch extension,		-		190,081 97
Belmont extension,		-		57,363 06
Malden extension,		-		67,092 63
Bulkhead, Chelsea Creek,		-		3,231 00
North System, enlargement: —				
Administration,	$3,119 25		$8,917 77	
Deer Island pumping station, extensions and additions,	57,308 03		177,707 76	
East Boston pumping station, extensions and additions,	133,724 83		160,175 85	
Malden-Everett extension, Section 66,	632 20		632 20	
Stable and locker, East Boston,	14,281 23		14,362 38	
		$209,065 54		361,795 96
Total for North Metropolitan System,		$209,065 54		$6,521,196 15
South Metropolitan System.				
Charles River valley sewer, main line,		-		$800,046 27
Neponset River valley sewer: —				
Main line,		-	$866,595 66	
Brookline branch,		-	44,935 80	
				911,531 46
High-level Sewer,		-		5,992,375 01
Amount carried forward,				$7,703,952 74

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
Amount brought forward,	. . . . . .			$7,703,952 74
South Metropolitan System — Con.				
High-level Sewer extension: —				
Completed sections,	-		$831,627 43	
Administration,	$128 29		15,064 14	
Section 85, Brighton,	519 80		227,375 50	
Hough's Neck pumping station and connections,	6,640 88		6,640 88	
Land takings, purchase and recording,	192 87		8,118 95	
		$7,481 84		1,088,826 90
Total for South Metropolitan System,	. . .	$7,481 84		$8,792,779 64
Total for construction for both systems,	. . .	$216,547 38		$15,313,975 79

MAINTENANCE.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
North Metropolitan System,	$160,751 00	$1,736,573 10
South Metropolitan System,	101,781 68	1,411,066 98
Total for maintenance, both systems,	$262,532 68	$3,147,640 08

(7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage Acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1910: —

(a) Expenditures and Disbursements.

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.	
North Metropolitan System.	
Administration: —	
Commissioners,	$1,166 67
Secretary,	375 00
Clerks and stenographers,	895 34
Amount carried forward,	$2,437 01

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.	
Amount brought forward,	$2,437 01	
North Metropolitan System — Con.		
Administration — *Con.*		
Traveling,	-	
Stationery, printing and office supplies,	404 70	
Telephone, lighting, heating, water and care of building,	133 39	
Rent and taxes, main office,	113 51	
Repairs of building,	7 62	
Miscellaneous expenses,	23 02	
		$3,119 25
Engineering: —		
Chief engineer,	$833 33	
Engineering assistants,	4,784 52	
Inspectors,	4,110 84	
Traveling expenses,	320 71	
Stationery, printing and office supplies,	155 69	
Engineering and drafting instruments and tools,	1 60	
Engineering and drafting supplies,	73 87	
Telephone, lighting, heating, water and care of building,	404 77	
Rent and taxes,	340 52	
Repairs of building,	22 88	
Miscellaneous expenses,	1,253 80	
		12,302 53
Advertising,	$36 73	
Labor and teaming,	26,448 17	
Tools, machinery and appliances,	12,727 03	
Brick, cement, lumber and other field supplies and expenses,	12,017 06	
		51,228 99
Contracts: —		
Woodbury & Leighton Co., contract 74, extension of engine, boiler, screen-house and coal-house at East Boston pumping station,	$80,810 41	
Allis-Chalmers Co., contract 68, addition to pumping plant at Deer Island pumping station,	17,307 50	
Robb-Mumford Boiler Co. (Robb Engineering Co., Ltd., assignee), contract 78, furnishing and erecting six vertical fire-tube boilers with smoke flue and galleries, at the East Boston pumping station,	25,546 40	
Hyde Windlass Co., contract 79, furnishing two sets of screens for the Deer Island pumping station,	5,600 00	
John T. Scully Foundation and Transportation Co., contract 80, pile wharf, steel floor beams, braces and coal runs, for the East Boston pumping station,	8,618 91	
		137,883 22
Real estate: —		
Settlements,	$4,463 40	
Legal, conveyancing and expert,	68 15	
		4,531 55
Total for North Metropolitan System,	. . . .	$209,065 54

General Character of Expenditures.	For the Year ending December 31, 1910.	
South Metropolitan System.		
High-level Sewer Extension.		
Administration: —		
Commissioners,	-	
Secretary,	-	
Clerks and stenographers,	-	
Traveling,	-	
Stationery, printing and office supplies,	$90 71	
Telephone, lighting, heating, water and care of building,	26 26	
Rent and taxes, main office,	11 32	
Miscellaneous expenses,	-	
		$128 29
Engineering: —		
Chief engineer,	-	
Engineering assistants,	$1,132 83	
Inspectors,	402 78	
Traveling expenses,	-	
Stationery, printing and office supplies,	79 35	
Engineering and drafting instruments and tools,	-	
Engineering and drafting supplies,	8 18	
Telephone, lighting, heating, water and care of building,	78 70	
Rent and taxes,	33 95	
Miscellaneous expenses,	-	
		1,735 79
Advertising,	$34 89	
Labor and teaming,	31 00	
Tools, machinery and appliances,	474 43	
Brick, cement, lumber and other field supplies and expenses,	1,438 89	
		1,979 21
Contracts: —		
Hugh Nawn Contracting Co., contract 65, Section 85, in part,	$500 00	
John Cashman & Sons Co., contract 87, Hough's Neck pumping station,	2,945 68	
		3,445 68
Real estate: —		
Settlements,	$192 87	
Legal, conveyancing and expert,	-	
		192 87
Total for South Metropolitan System,		$7,481 84
MAINTENANCE AND OPERATION OF WORKS.		
North Metropolitan System.		
Administration: —		
Commissioners,	$2,333 33	
Secretary and assistants,	2,971 25	
Rent,	325 43	
Amount carried forward,	$5,630 01	

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.	
Amount brought forward,	$5,630 01	
North Metropolitan System — Con.		
Administration — *Con.*		
Heating, lighting and care of building,	216 62	
Repairs of building,	128 38	
Postage,	86 00	
Printing, stationery and office supplies,	692 89	
Telephones,	59 28	
Traveling expenses,	35 91	
Miscellaneous expenses,	41 63	
		$6,890 72
General supervision: —		
Chief engineer and assistants,	$6,387 59	
Rent,	976 32	
Heating, lighting and care of building,	614 15	
Repairs of building,	385 17	
Postage,	-	
Printing, stationery and office supplies,	249 07	
Telephones,	177 85	
Traveling expenses,	155 00	
Miscellaneous expenses,	76 83	
		9,021 98
Deer Island pumping station: —		
Labor,	$15,669 91	
Fuel,	12,341 20	
Oil and waste,	439 66	
Water,	1,268 40	
Packing,	264 16	
Repairs and renewals,	1,244 57	
Telephones,	195 05	
General supplies,	1,561 00	
Miscellaneous supplies and expenses,	231 72	
		33,215 67
East Boston pumping station: —		
Labor,	$18,317 42	
Fuel,	10,362 06	
Oil and waste,	424 80	
Water,	1,644 00	
Packing,	50 24	
Repairs and renewals,	623 08	
Telephones,	140 95	
General supplies,	636 68	
Miscellaneous supplies and expenses,	113 93	
		32,313 16
Charlestown pumping station: —		
Labor,	$14,209 60	
Fuel,	3,838 56	
Oil and waste,	266 74	
Amounts carried forward,	$18,314 90	$81,441 53

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.	
Amounts brought forward,	$18,314 90	$81,441 53
North Metropolitan System — Con.		
Charlestown pumping station — *Con.*		
Water,	453 60	
Packing,	33 27	
Repairs and renewals,	364 99	
Telephones,	67 85	
General supplies,	323 02	
Miscellaneous supplies and expenses,	97 56	
		19,655 19
Alewife Brook pumping station: —		
Labor,	$7,558 00	
Fuel,	1,795 84	
Oil and waste,	231 20	
Water,	276 84	
Packing,	60 63	
Repairs and renewals,	461 03	
Telephones,	50 22	
General supplies,	85 15	
Miscellaneous supplies and expenses,	43 25	
		10,562 16
Sewer lines, buildings and grounds: —		
Engineering assistants,	$2,575 00	
Labor,	24,996 32	
Automobiles,	88 82	
Brick, cement and lime,	628 14	
Castings, ironwork and metals,	273 25	
Freight, express and teaming,	10 66	
Fuel and lighting,	270 18	
Jobbing and repairing,	119 69	
Lumber,	592 82	
Machinery, tools and appliances,	545 13	
Paints and oils,	539 64	
Rubber and oiled goods,	685 82	
Sand, gravel and stone,	286 06	
Telephones,	10 10	
Traveling expenses,	504 19	
General supplies,	575 24	
Miscellaneous expenses,	274 73	
		32,975 79
Horses, vehicles and stable account,	$4,356 33	
Renewal East Boston pumping station, account Chelsea fire, April 12, 1908: —		
Supplies and expenses,	11,760 00	
		16,116 33
Total for North Metropolitan System,		$160,751 00
South Metropolitan System.		
Administration: —		
Commissioners,	$2,333 33	
Secretary and assistants,	1,745 12	
Amount carried forward,	$4,078 45	

General Character of Expenditures.	For the Year ending December 31, 1910.	
Amount brought forward,	$4,078 45	
South Metropolitan System — Con.		
Administration — *Con.*		
Rent,	155 00	
Heating, lighting, and care of building,	201 85	
Repairs of building,	64 20	
Postage,	76 00	
Printing, stationery and office supplies,	623 56	
Telephones,	56 48	
Traveling expenses,	10 51	
Miscellaneous expenses,	27 78	
		$5,293 83
General supervision: —		
Chief engineer and assistants,	$7,561 59	
Rent,	465 00	
Heating, lighting and care of building,	605 57	
Repairs of building,	192 58	
Postage,	-	
Printing, stationery and office supplies,	180 09	
Telephones,	169 35	
Traveling expenses,	60 00	
Miscellaneous expenses,	102 28	
		9,336 46
Ward Street pumping station: —		
Labor,	$18,446 92	
Fuel,	6,850 69	
Oil and waste,	329 24	
Water,	1,410 00	
Packing,	111 65	
Repairs and renewals,	336 82	
Telephones,	95 49	
General supplies,	971 88	
Miscellaneous supplies and expenses,	162 77	
		28,715 46
Quincy pumping station: —		
Labor,	$6,273 60	
Fuel,	1,654 52	
Oil and waste,	44 01	
Water,	114 85	
Packing,	24 66	
Repairs and renewals,	273 25	
Telephones,	37 82	
General supplies,	82 79	
Miscellaneous supplies and expenses,	247 57	
		8,753 07
Nut Island screen-house: —		
Labor,	$7,129 17	
Fuel,	1,568 45	
Oil and waste,	56 51	
Amounts carried forward,	$8,754 13	$52,098 82

General Character of Expenditures.	For the Year ending December 31, 1910.	
Amounts brought forward,	$8,754 13	$52,098 82
South Metropolitan System — Con.		
Nut Island screen-house — *Con.*		
Water,	179 28	
Packing,	28 69	
Repairs and renewals,	29 11	
Telephones,	60 80	
General supplies,	429 96	
Miscellaneous supplies and expenses,	40 29	
		9,522 26
Sewer lines, buildings and grounds: —		
Engineering assistants,	$3,400 00	
Labor,	18,653 48	
Automobiles,	2,411 87	
Brick, cement and lime,	136 03	
Castings, ironwork and metals,	109 16	
Freight, express and teaming,	25	
Fuel and lighting,	71 72	
Jobbing and repairing,	19 64	
Lumber,	119 38	
Machinery, tools and appliances,	2,858 48	
Paints and oils,	427 52	
Rubber and oiled goods,	163 21	
Sand, gravel and stone,	18 75	
Telephones,	34 85	
Traveling expenses,	605 24	
General supplies,	149 83	
Miscellaneous expenses,	30 63	
		29,210 04
City of Boston, for pumping and interest,	. . . .	7,700 00
Horses, vehicles and stable account,	. . . .	3,250 56
Total for South Metropolitan System,	. . . .	$101,781 68

(*b*) *Receipts.*

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

Account.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
North Metropolitan System — construction,	$254 59	$63,391 78
South Metropolitan System — construction,	1,994 31	13,401 13
North Metropolitan System — maintenance,	3,081 59	14,641 23
South Metropolitan System — maintenance,	253 50	1,730 20
Metropolitan Sewerage Loans Sinking Fund,	182 19	1,543 39
Totals,	$5,766 18	$94,707 73

(c) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate connected therewith.

(d) *Liabilities.*

The sums due on monthly pay rolls amount to $757.22, and there are other current bills unpaid which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
High-level Sewer: —		
National Contracting Co.,	Sect. 73, contract abandoned,	$5,516 17[1]
E. W. Everson & Co.,	Sect. 75, contract 14,	1,000 00
High-level Sewer Extension: —		
Timothy J. O'Connell,	Sect. 82, in part, contract 57,	60 00
Geo. M. Bryne Co.,	Sect. 85, in part, contract 63,	2,508 51
John Cashman & Sons Co.,	Hough's Neck pumping station and connections, contract 87,	519 82
North Metropolitan Construction: —		
Allis-Chalmers Co.,	Addition to pumping plant at Deer Island pumping station, contract 68,	17,307 50
Robb-Mumford Boiler Co. (Robb Engineering Co., Ltd., assignee),	Furnishing and erecting six vertical fire-tube boilers with smoke flue and galleries, at the East Boston pumping station, contract 78,	6,386 60
Woodbury & Leighton Co.,	Extension of engine, boiler, screen-house and coal house at East Boston pumping station: —	
	Contract 74A (maintenance),	865 00
	Contract 74B (construction),	8,681 73
		$42,845 33

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[1] Damages claimed by the Commonwealth on account of the abandonment of the contract exceed this amount.

Claims have been made by the following parties, but it is impossible to state the amounts due for land and other damages, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them: —

Anna L. Dunican, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Richard Jones, James Doherty, Michael Niland, William H. Gibbons, Francis Normile, George A. Goddard.

VIII. RAINFALL AND WATER SUPPLY.

The amount of rain has been almost unprecedentedly small during the past year, and the scarcity has been more felt because for a period of years preceding there has been a rainfall less than the normal. The average rainfall for the past thirty-six years in which the records have been kept on the Sudbury watershed, is 45.31 inches, but during the past year the rainfall was but 35.64 inches. The rainfall on the Wachusett watershed was but 37.85 inches, against an average rainfall of 47.08 inches since the beginning of the records in the year 1897.

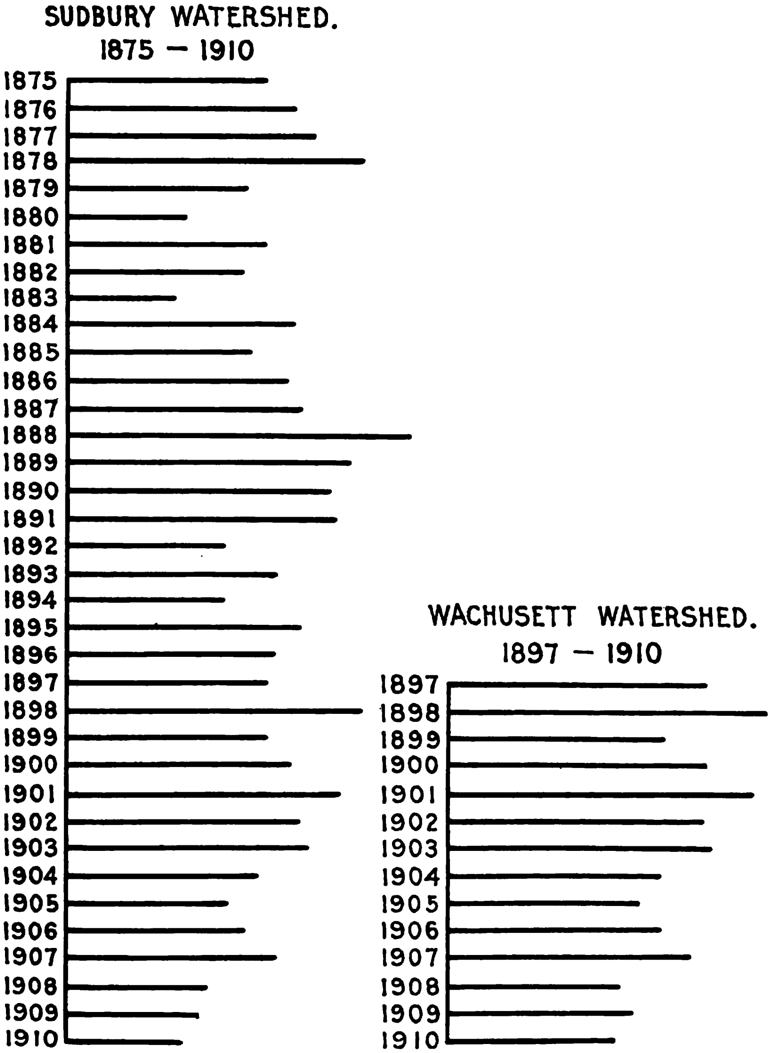
The amount of water collected and contributed to the water supply, which is affected by various circumstances, does not, however, exactly correspond to the rainfall. The yield or amount of water collected on the Sudbury watershed in the year 1910 was only 56 per cent. of the average amount of the years since the measurements have been made; and the amount so collected on the Wachusett watershed was but 73 per cent. of the average.

The accompanying diagram illustrates the remarkably small amount of water collected for the water supply during the past year in comparison with the previous years, and it also shows the comparatively smaller amounts collected during the past few years.

IX. CONSUMPTION OF WATER.

There has been for the second year a gratifying reduction in the total consumption of water in the Metropolitan District. The daily average consumption of water in the District in the year 1910 has been 112,092,100 gallons, which is a decrease of 7,027,000 gallons from the consumption of the year 1909, while that year showed a decrease in the daily average consumption of 6,305,100 gallons. The daily average consumption of each person in the District was 110 gallons, as against 119 gallons per person in the year 1909, and 129 gallons per person in the year 1908. These are the quantities determined by the Venturi meters as delivered to the various cities and towns. The quantity delivered to the District, according to the computation of water pumped at the several pumping stations and flowing in the Weston Aqueduct, including the small yield of the Spot Pond watershed, would, principally

COMPARATIVE AMOUNTS OF WATER COLLECTED IN THE DIFFERENT YEARS ON THE SUDBURY AND WACHUSETT WATERSHEDS PER SQUARE MILE OF WATERSHED.



owing to leakage from distributing reservoirs and the Metropolitan pipes, and the small amounts supplied outside of the District, slightly exceed these figures.

There has been a decrease in daily consumption per capita in all the municipalities except Arlington, Belmont, Lexington, Malden, Melrose, Revere, Stoneham, Swampscott and Watertown. In the town of Winthrop there has been a decrease of 28 gallons daily per capita, and in the city of Medford a decrease of 16 gallons daily per capita, while in the city of Boston the daily per capita decrease has been 13 gallons. The total reduction of the consumption of the latter city for the year was 6,683,200 gallons, which makes up nearly the entire reduction in consumption of the District.

Of the municipalities named, in which there has been a per capita increase in the consumption, Stoneham shows a daily increase of 9 gallons and Watertown of 8 gallons. In the other municipalities the per capita increases have been small.

The notable reductions in the consumption in the cities of Boston and Medford and in the town of Winthrop have followed the larger installation of meters in those municipalities.

Although the reduction in consumption during the past year was assisted by the generally favorable character of the weather, and by the adoption on the part of the municipalities of more rigorous inspection and other preventive measures, it is undoubtedly principally due to the larger introduction of meters.

During the past year there has been a substantial compliance with the provisions of the Meter Act of 1907 by all the municipalities except the town of Revere and the city of Quincy. The city of Boston, on account of its almost total failure to observe the requirements of the law in the year 1908, is still behindhand in the total required to be installed on services in use on January 1, 1908 by about 2,200 meters, and its per cent., 19.96 per cent. of services metered, is the lowest of any municipality.

The town of Revere, although it introduced meters upon its new services, installed them upon less than 5 per cent. of old services as required by the Meter Act.

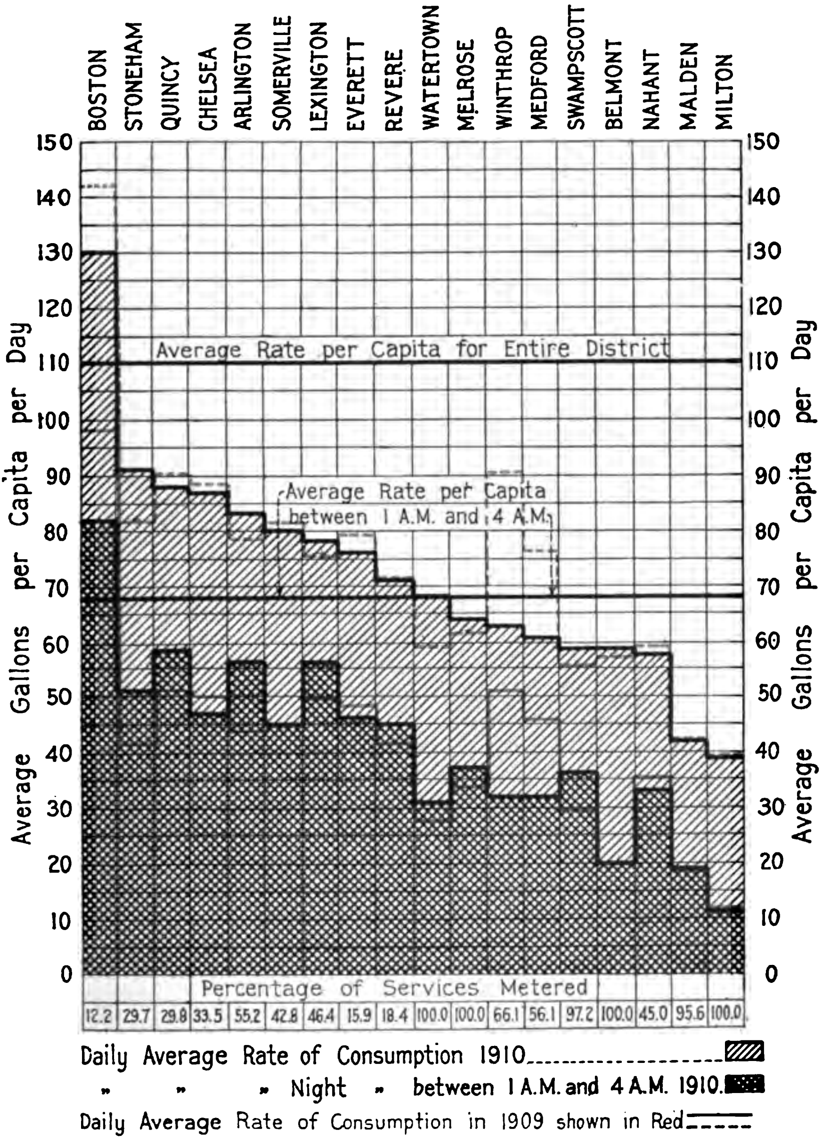
The city of Quincy failed in the year 1909 to comply with the provisions of the Meter Act, both as to the metering of the required percentage of old services and in the equipment of all new services.

The Board, in compliance with the provisions of chapter 177 of the Acts of 1909, gave notice of the neglect of the city to the Attorney-General, who brought action before the Supreme Judicial Court to enforce the requirements of the Act, and also for the forfeiture to the Commonwealth of the penalties prescribed. By reason, however, of the representations made by the officials of the city as to the measures which they were taking in order to install the necessary number of meters, further proceedings in the suit were suspended. A large number of meters were installed during the latter portion of the year, and it is understood that during the coming year the city will have fully complied with the terms of the Act, and will not compel the further prosecution of the action which is pending.

The city of Melrose and the towns of Belmont, Milton and Watertown have metered all their services. The town of Swampscott, the city of Malden, the town of Winthrop and the city of Medford have installed meters to the extent respectively of 99, 96, 96 and 94 per cent. of the services. At the end of the year, 37.56 per cent. of all the services in the Metropolitan District were metered, a gain during the year of 9.21 in the percentage.

The fact still remains, notwithstanding the reductions which have been made, that there is an excessive use and great waste of water in the Metropolitan District. The diagram which is again reproduced, showing the average rate of consumption in the year 1910 during the entire day and between the hours of 1 and 4 in the night, significantly demonstrates this fact. The daily average rate of consumption per capita in the night, when necessary use is comparatively very small, is 68 gallons. This night rate in the city of Boston is 60 per cent. of the rate for the entire day, and exceeds the rate for the entire day of 13 municipalities. The result which has been brought about by the metering of even 19.96 per cent. of the services in the city of Boston, and the somewhat greater efforts which have been made by the authorities to restrict unnecessary use, conclusively indicate the importance of universal metering and more vigorous measures for the prevention of excessive use and waste, especially in that city which consumes 78 per cent. of all the water supplied. The city of Boston alone can put off for a long period in the future the necessity of a great expenditure for the acquisition of additional sources of supply and of new and expensive works.

DIAGRAM SHOWING AVERAGE RATE OF CONSUMPTION OF WATER IN THE METROPOLITAN DISTRICT IN 1910 DURING THE ENTIRE DAY AND BETWEEN THE HOURS OF 1 AND 4 AT NIGHT



X. RECOMMENDATIONS FOR LEGISLATION.

The Board in its preliminary report to the Legislature has made no requests for the authorization of additional expenditures for the construction of new works, either for the Water or Sewerage systems, and the loans already authorized are deemed sufficient for the completion of the works in progress.

The Board has requested the passage of an act providing that in case the town of Braintree should apply for admission into the South Metropolitan Sewerage District, and an extension of the sewer into that town should thus become necessary, balances in the treasury not needed for the purposes for which the appropriations were made may be used for the Braintree extension, and thus avoid the necessity of the immediate issue of further bonds.

XI. FUTURE WORK.

The maintenance and operation of the various works for the supply and distribution of water in the cities and towns of the Metropolitan Water District, and of the works constructed for the collection and disposal of the sewage in the cities and towns of the North and South Metropolitan Sewerage districts, will require, according to the estimates for the current year which have been made and submitted to the Legislature, appropriations amounting to $674,400. In these estimates, in addition to the ordinary current expenditures, the Board has included the sum of $15,000, which it deems necessary to expend for the protection of the water supply in aqueducts. The growth of the population having caused the construction of new houses in districts adjacent to the aqueducts before local sewers have been provided, it has become necessary to provide, temporarily at least, for the house drainage in such adjacent districts so as to prevent the pollution of the water carried through the aqueducts.

The carrying out of projects already begun will require a considerable amount of construction during the coming year. The installation of a power plant at the Wachusett Dam, by which electricity will be generated and for which contracts have already been made, will be carried on to completion. The tunnel and pipe line for the improvement of the East Boston water supply will be finished and put into operation, a further section of the 60-inch supply pipe line, which is to extend from the Weston Aqueduct to the Chestnut Hill Reservoir, will be made ready and put into service, and the new engine, which is in process of erection at the Chestnut Hill pumping station, will be completed and put into operation.

In the North Sewerage System the final work in the extensions of the Deer Island and East Boston pumping stations and installation of new pumping machinery will be accomplished, and the new stable and locker building will be constructed; and in the South Sewerage System the small station in process of construction for lifting the sewage of a portion of the city of Quincy into the High-level Sewer will be completed and put into operation. If the town of Braintree applies for admission into the South Metropolitan Sewerage District it will be necessary to proceed at once to the construction of a sewer from a point in Quincy to connect with the sewerage system in the town of Braintree, for which the expenditure of $100,000 has been authorized.

Requests for information have been made by various municipalities relative to their admission into the Metropolitan Water District. Some of these municipalities are situated within the ten-mile limit, and it is made by the Metropolitan Water Act obligatory upon the Board to grant their applications for admission on their payment of such sums as the Board shall determine. Municipalities outside of the limit can only be admitted by act of the Legislature. In case other cities or towns are admitted new work of greater or less magnitude will be called for.

The town of Hyde Park, which belongs to the Metropolitan Water District, but has not yet asked to be furnished with water, has been considering for some time the question of resorting to the Metropolitan Works for its supply. In case the town shall so vote it will become at once the duty of the Board to proceed to make connection with the local water system of the town, and construct such new works as may be required in order to furnish a proper water supply.

The large amount of sewage which is now carried into the harbor through the Deer Island outlet has caused the Board to consider the desirability of making some improvement in the future in the method of its discharge. Various inquiries have been instituted in the matter, but further investigations will be required as to the effect of the disposal of the sewage in the harbor and to determine what measures may be adopted in order to secure the best and most effective method by which the sewage can be discharged into the sea from the North Metropolitan System.

The detailed reports of the Chief Engineer of the Water Works and of the Chief Engineer of the Sewerage Works, with various tables and statistics are herewith presented.

Respectfully submitted,

HENRY H. SPRAGUE,
HENRY P. WALCOTT,
JAMES A. BAILEY, Jr.,
Metropolitan Water and Sewerage Board.

Boston, February 27, 1911.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following is a report of the work under the charge of the Chief Engineer of the Metropolitan Water Works for the year ending December 31, 1910.

GENERAL STATEMENT.

The Chief Engineer has charge of the design and construction of all new works, and of the maintenance and operation of all the works controlled by the Metropolitan Water and Sewerage Board for supplying water to the eighteen municipalities which have received their supply from the Metropolitan Works.

ORGANIZATION.

The Chief Engineer has had the following assistants: —

William E. Foss, . .	*Assistant to Chief Engineer.*
Elliot R. B. Allardice, .	*Superintendent, Wachusett Department.*
Charles E. Haberstroh,	*Superintendent, Sudbury Department.*
Samuel E. Killam, .	*Superintendent, Pipe Lines and Reservoirs, Distribution Department.*
Arthur E. O'Neil, . .	*Superintendent, Pumping Stations, Distribution Department.*
Alfred O. Doane, . .	*Division Engineer, specially in charge of engineering work at pumping stations.*
George E. Howe, . .	*Assistant Engineer, resigned April 30, 1910.*
Barzillai A. Rich, . .	*Assistant Engineer, employed since June 8, 1910.*
Clifford Foss, . .	*Assistant Engineer.*
Benjamin F. Hancox, .	*Assistant, in charge of Drafting Department.*
James W. Killam, .	*Assistant Engineer, in charge of tests of coal and oil.*
William E. Whittaker, .	*Office Assistant.*
Arthur W. Walker, .	*Biologist.*
William W. Locke, .	*Sanitary Inspector.*

At the beginning of the year the engineering force, including those engaged upon both the construction and maintenance of the works, numbered 48, and at the end of the year 51.

There has also been a maintenance force, exclusive of the engineers above mentioned, averaging 249, employed in the operation of the several pumping stations and in connection with the maintenance of the reservoirs, aqueducts and pipe lines, and in doing minor construction work.

The number of men employed in the maintenance force of the several departments has been as follows: —

	Beginning of Year.	End of Year.	Average.
Wachusett Department,	37	39	49
Sudbury Department.	43	56	53
Distribution Department, pipe lines and reservoirs,	76	91	88
Distribution Department, pumping service,	60	58	59
	216	244	249

In addition to the men employed directly by the Board a force averaging 167 men, reaching a maximum of slightly over 300 in September, was employed from April 1 to December 31 by the contractors engaged in constructing new works.

CONSTRUCTION.

New 60-inch Supply Main from Weston Aqueduct.

An expenditure of $750,000 was authorized by the Legislature of 1909 for the construction of a second Weston Aqueduct supply main, for the purpose of increasing the amount of water that can be supplied from the Weston Aqueduct into the Metropolitan District.

The new main will extend from the Charles River at Commonwealth Avenue in Newton to Beacon Street at Chestnut Hill Avenue in Boston, a distance of about 34,650 feet, and will be located for a large portion of the distance in Commonwealth Avenue. On account of the large reduction now being made in the amount of water used in the District it has not been deemed necessary to construct the entire line at present, and the work of construction is therefore being confined to the portion of the line extending 20,255 feet westerly from the lower end, at Beacon Street in Boston. This section of the pipe line has been connected at the lower end with the low-service mains in Beacon Street, and at the upper end it will be connected with the existing 48-inch Weston Aqueduct supply main, near Valentine Street, in Newton, and when put into service it will materially increase the amount of water that can be drawn from the Weston Aqueduct.

Cast-iron pipes 60 inches in diameter have been used in constructing the line, except for a distance of 2,395 feet, where the water will be carried through a concrete-lined rock tunnel 76 inches in diameter, connected with the 60-inch pipes by steel pipes 80 inches in diameter. The steel pipes will be protected from corrosion on the inside by a Portland cement mortar lining 2 inches thick, and on the outside by a backing of Portland cement concrete, which will also serve as a support for the pipe.

The tunnel and steel pipe line are being constructed of larger capacity than the remainder of the line in order to provide carrying capacity for an additional pipe line in the future.

Contracts for furnishing the cast-iron pipe and most of the special castings for the portion of the line now under construction were made in 1909. Contracts for the special castings required to complete the work have been made during the past year. A contract for furnishing the steel pipe was made with the Hodge Boiler Works on December 6, but the delivery of the pipe will not be made until 1911. The portion of the pipe line under construction has been subdivided into three sections, known as sections 6, 7 and 8.

Section 6 is located in Commonwealth Avenue in Newton, and extends from a point midway between Prince and Valentine streets to Grant Avenue, at Section 7, a distance of 8,825 feet. The contract for doing this work was made with Cavanagh Brothers of Boston, on June 2. On the following day a special steam shovel excavator, designed by the contractor, was set up near Grant Avenue, where trench excavation was started on June 8. Pipe laying was begun at this point on June 15 and on July 16 about 650 feet of pipe had been laid. The force employed at this time was about 35 men.

On account of difficulties arising in connection with the use of the steam shovel and dump cars, and from obstacles encountered in the trench, slow progress was made in pipe laying. The contractor therefore increased his force to about 75 men, abandoned the use of the cars, and employed teams for transporting the excavated material. This change in method of carrying on the work resulted in the making of better progress and this organization was continued until the completion of the work.

Trench excavation was started at the large culvert near Walnut Street on July 18, and 700 feet of trench at this place was excavated by manual labor. Pipe laying was completed and the line capped at the westerly end, between Prince and Valentine streets, on November 26.

A 36-inch branch was set in the line near Valentine Street for a connection with the 48-inch Weston Aqueduct supply main. A 36-inch valve with 6-inch by-pass was set in the line just west of this branch. A blow-off branch into the Cochituate Aqueduct was placed at Irving Street.

The surplus material from the easterly 6,000 feet of the line was sand and gravel, and was teamed to Section 7, where a portion of it was used in building the embankment over the 60-inch pipe line, and the remainder placed in a storage pile to be used for filling the steel pipe trench on that section. The entire work was completed on December 3. The value of the work done under this contract was $40,777.77.

Section 7 of the new pipe line is located in Newton, and extends from Commonwealth Avenue at Grant Avenue through and under private land to the westerly end of Section 8. It includes 2,042 feet of concrete-lined rock tunnel, 353 feet of cement-lined steel pipe and 940 feet of 60-inch cast-iron pipe.

A contract for this work was made with Joseph Hanreddy of Chicago on April 28. The work of excavating the trench at the west end of the section was begun on May 24, with a force of about 20 men and 9 horses, preparatory to laying the pipe at this place. This force was later increased to about 55 men.

Steam plants, with air compressors for operating the drills, dynamos for lighting the tunnel and engines for operating the stone crushers have been installed at both ends of the tunnel.

The laying of 60-inch pipe was begun at Commonwealth Avenue on June 7, and continued in an easterly direction until June 14, when 334 feet of pipe had been laid. This section of the line was laid near the surface of the ground, and covered with an embankment built of surplus material from the 60-inch pipe trench on Section 6.

On June 17 the laying of pipe was begun at the easterly end of the section, and continued westerly until July 1, when 185 feet of pipe had been laid. A 36-inch valve with 6-inch by-pass was set in the line at this point, and a 16-inch blow-off pipe was laid into the culvert under the Cochituate Aqueduct near the ventilator chamber. Pipe laying was resumed at this place on September 15 and continued to October 1. The total length of 60-inch pipe laid to date on this section is 664 feet.

On July 7 the steam plant at the west end of the tunnel was put into operation, and on July 13 the crushing of rock from the open trench was commenced. Rock excavation in the open trench was completed July 23, and tunnel excavation was begun on July 26 at the west portal. Night work was begun at the west heading on August 1, and tunnel excavation was then continued with two shifts at this heading.

The tunnel is excavated 9 feet in diameter, and is located about 9 feet north of and 20 feet above the old Cochituate Aqueduct tunnel, which was constructed through the hill at this place by the city of Boston in 1848.

Tunnel excavation was begun at the east portal on September 9, and night work was commenced on September 19. The excavation of the tunnel was then continued, with night and day forces, from the east portal until December 24, and from the west portal until December 29. The force employed at each heading consisted of about 12 men on each shift. From 15 to 21 holes, from 5 to 6 feet in depth, were drilled per shift in each heading, and then blasted, and the progress made when working two shifts at both headings was about 20 linear feet per working day.

The material excavated at the west heading was soft conglomerate rock, with a few hard spots in places, and comprised about three-fourths of the tunnel excavation. This rock was free from seams and broke close to the established line for tunnel excavation. At the east end of the tunnel the rock was hard and brittle, with numerous fissures and cracks, which caused the excavation to break out unnecessarily large at some places, and timbering was required for about 30 feet. Timbering was also required to support the rock at six old shafts on the Cochituate Aqueduct tunnel, and at an earth seam near the westerly end of the tunnel.

On December 28 a hole was broken through from the west heading into the east heading of the tunnel. After the muck was removed the entire force was discharged, and the work suspended for the winter on December 31. With the exception of a little trimming the tunnel excavation is now completed.

The value of the work done to date under this contract is $65,385.41, equivalent to about 60 per cent. of the total value of the work to be done.

At the west end the length of tunnel excavation was 1,210 feet, and at the east end 832 feet, making a total length of 2,042 feet. The average length of tunnel excavated per working day was 15.1 feet. At the west end of the tunnel 5,553 cubic yards of stone have been crushed, of which 1,924 cubic yards have been used for resurfacing the 60-inch pipe trench in Commonwealth Avenue. At the east end of the tunnel 4,226 cubic yards of stone have been crushed.

About 2.30 A.M. on December 6, powderman Constanzo Tramanbozzi was killed by the explosion of the dynamite which was to be used for loading the holes in the east heading of the tunnel. The cause of the explosion is not known.

Section 8 includes the easterly 8,095 feet of the proposed line, 3,100 feet of which is located in private land in Newton and 4,995 feet in Commonwealth and Chestnut Hill avenues in Boston.

Work on this section, which was begun last year by the Charles J. Jacobs Company, was suspended for the winter on December 24, 1909, after 5,349 feet of pipe had been laid. The work was resumed on March 30, 1910, and was continued with a force of from 40 to 80 men. The work progressed slowly, on account of the large amount of rock which had to be excavated in the trenches on Commonwealth Avenue, and was not completed until August 10.

A 60-inch Venturi meter, with 27-inch throat, was set in the pipe line on Chestnut Hill Avenue near Beacon Street, where the main connects with the existing 48-inch main.

The value of the work done by the C. J. Jacobs Company during the year was $14,622.86, making the total cost of the work done by this contractor $40,525.39.

The length of 60-inch pipe laid during the year was 2,746 feet, making a total length laid of 8,095 feet, and the amount of rock excavated during the year was 1,092 cubic yards, making a total of 3,610 cubic yards.

The value of all work done on the construction of the new supply main to date is as follows: —

Pipes, special castings and valves,	$209,710 61
Venturi meter,	2,350 00
Laying pipes, including pipe-laying materials and earth excavation,	61,061 58
Rock excavation in trenches,	15,735 50
Tunnel excavation, Section 7,	50,245 50
Earth excavation for trenches, Section 7,	3,712 20
Crushing stone, Section 7,	7,334 25
Valve chambers and concrete backing for curves,	2,407 00
Work in connection with changes in underground structures,	6,765 56
Resurfacing trench in Commonwealth Avenue, Section 6, labor by city of Newton,	4,357 16
Additional expenses,	9,854 64
Engineering,	15,173 08
Total,	$388,707 08

16-INCH FORCE MAIN IN ARLINGTON.

The 16-inch main leading from the Arlington pumping station has been extended from Massachusetts Avenue through Robbins Road, Hawthorne and Park avenues to the standpipe on Arlington Heights, a distance of 3,750 feet. The work of laying the main was done by Devincenzi & Baruffoldi under a contract dated May 5, 1910. The contractor began work on May 11, employed an average force of 22 men and completed the pipe laying on July 28. The value of the work done under this contract, which included the laying of 3,742 feet of 16-inch pipe and excavation of 408 cubic yards of rock, was $3,333.31. Connections between this main and existing pipes were made by the maintenance force, which also made 8 wooden insulating joints on the pipe line. The total cost of the work, exclusive of engineering, was $10,094.02.

The laying of this main reduced by about 5 feet the head or pressure on the pumps at the Arlington station, and at the same time relieved the pressure on the Arlington pipe system.

New 16-inch Main for Supply of Swampscott.

A 16-inch main 4,700 feet long has been laid from the corner of Ocean and Nahant streets in Lynn, through Ocean and New Ocean streets to the Swampscott line, for the purpose of improving the supply to the town of Swampscott. A contract for laying this main was made with C. M. Callahan on April 22, 1910. Work was begun at the Swampscott line on April 29. Pipe laying was completed on June 16 and the resurfacing of the trench on June 30. The new main was connected with the old 12-inch main at each end, and 11 wooden insulating joints were made on the line by the maintenance force.

The value of work done by contract was $4,518.30. The whole cost of the work, including work done by the maintenance force and materials used, was $14,009.70.

New Supply Main to East Boston.

The East Boston low-service district includes a thickly settled residential district with a population of 56,230, together with much valuable wharf property along the water front. For the past forty years this district has been dependent for its water supply upon two mains which are laid under the bed of Chelsea Creek, a tidal arm of the ocean separating East Boston from the mainland of Chelsea. The creek at the location where the pipes are laid is about 1,500 feet wide at high water, while the low-water channel is about 300 feet wide. At the channel the pipes are buried several feet below the bed of the creek, but on the flats on either side the pipes are supported on piles just above the surface of the mud, and are exposed twice each day at low tide.

For the purpose of guarding against the interruption of the supply to the district by the breaking of these mains, a 36-inch main is now being laid in a different location. The new main connects with existing 20-inch and 24-inch mains in Marginal Street, Chelsea, extends along the northerly shore of the creek about 3,800 feet to a point near the Chelsea Street Bridge leading to East Boston, where it turns easterly and crosses under the channel through a tunnel 504 feet long to the East Boston shore.

The new main is 30 inches in diameter for a distance of 729 feet from the connection with the old mains in Marginal Street to the corner of Shawmut and Essex streets. At this point the size of the pipe is increased to 36 inches in diameter, and a 36-inch branch is placed for future connection with the 42-inch main in Broadway, Chelsea. The 36-inch main extends easterly from this point through Essex and Highland streets and Congress Avenue, Marginal Street and Eastern Avenue to the Chelsea shaft of the tunnel under Chelsea Creek, a distance of 3,110 feet.

On account of the unstable nature of the ground the pipes are supported at the easterly end of this line for a distance of 1,700 feet upon a pile foundation, consisting of bents of 2 spruce piles capped with 10-inch x 10-inch spruce timber, the bents being spaced about 6 feet apart.

A contract for laying a portion of the pipe line in Chelsea was made with Michael Russo on August 10. Work was begun on August 15, and the contract was finished on December 8, at a cost of $13,086.10.

At the crossing of Chelsea Creek a tunnel 504 feet long has been constructed under pneumatic pressure.

The tunnel section includes a vertical shaft at each side of the creek, 9 feet 4 inches outside diameter, with the top at elevation 14 on the Chelsea shore and at elevation 10 on the East Boston shore. The horizontal section of the tunnel, joining the shafts, is 400 feet in length, 8 feet 2 inches outside diameter, with the top 36 feet below mean low water at the Chelsea end, and is located about 25 feet down-stream from the westerly side line of the Chelsea Street Bridge. The shafts were constructed with 12-inch brick walls and the horizontal portion of the tunnel with 8-inch brick walls. The Chelsea shaft rises about 12 feet above the bed of the creek, and is protected by a steel casing which extends about 13 feet into the silt bottom of the creek. The East Boston shaft was sunk through the earth filling back of the masonry sea wall, and is protected by a steel casing for a distance of 8 feet below the top. The axis of the horizontal section of the 36-inch pipe which is laid in the tunnel is 40 feet below Boston City Base at the Chelsea shaft.

The pipes are laid with a ½-inch opening between the end of the spigot and the bottom of the socket, and the joints are run solid with lead and calked both inside and outside after the pipe is laid. After the tunnel was excavated and lined the air pressure was removed, the 36-inch pipes are now being laid through the tunnel and the space between the pipes and the sides of the tunnel and shafts is being filled solid with Portland cement concrete. The tunnel section of the work is being done by day labor under the charge of Charles A. Haskin as superintendent.

The steam plant for operating the air compressors, hoists and electric lighting plant was set up on the Chelsea shore of the creek during the latter part of July, and the work of sinking the shaft was begun during the week ending August 13. After August 21, when the air lock was in place, the work was carried on continuously during twenty-four hours per day, with three shifts. While excavating the mud and silt just below the bed of the creek some inconvenience was experienced on account of gas, which entered the shaft and affected the eyes of the workmen.

The work of excavating and lining the shaft was completed about September 1. An air lock was then built at the entrance to the horizontal portion of the tunnel, and the small lock which had been used for sinking the shaft was removed. The excavation and lining of the horizontal portion of the tunnel progressed at the rate of about 5 feet per day. The air pressure maintained varied from 14 to 23 pounds per square inch, according to the stage of the tide in the creek above.

On October 13 a blow-out occurred about 150 feet from the Chelsea shaft at a point where a pile had been removed. As a result, the tunnel was flooded with water to a depth of about 4 feet. After the hole was stopped the water was pumped out, and the work proceeded without further mishap.

On the East Boston side of the creek the material excavated was hardpan containing boulders, which required some blasting, so that the rate of progress was less than it had been in the sand and clay on the Chelsea side of the creek. A 2½-inch steel pipe was driven, during the week ending November 12, on the centre line of the tunnel near the East Boston end, from the surface of the ground to the centre of the tunnel, for use in supplying compressed air for sinking the East Boston shaft.

Work in the tunnel was discontinued on November 17, when steel sections of the East Boston shaft and the hoisting engine were set up on the East Boston side of the creek. On November 18 the work of excavating the East Boston shaft was begun, and on November 24 air pressure was applied.

An opening was made from the bottom of the shaft into the tunnel on December 3. All excavation and the brick lining for the tunnel were completed on December 6, and the air pressure was removed on the morning of December 9. A total of 104 linear feet of shaft and 400 feet of tunnel were built. The tunnel was cleaned out and plastered, and, after calking a few small leaks, was substantially water tight. At the end of the year 46.5 feet of 36-inch pipe had been laid in the East Boston shaft and the concrete masonry had been completed for a length of 38 feet. In the tunnel 160 feet of 36-inch pipe had been laid and the concrete masonry had been completed for a length of 157 feet.

The force employed on this work while working continuously under air pressure averaged about 15 men for each of the three shifts. After the air pressure was removed the work was carried on with three shifts working six days per week, the force employed averaging about 16 men per shift.

A 20-inch Venturi meter with 8-inch throat was installed by the maintenance force at the end of the line in East Boston, where connection was made with the Boston Water Works 30-inch main.

The cost of the work done on this new main to the end of the year was as follows: —

Section 37.		
Pipes, valves and special castings,	$22,092 42	
Laying pipes, including pipe-laying materials and earth excavation,	6,830 90	
Pile driving and timber foundation,	3,533 08	
Valve chambers and concrete backing for curves,	579 00	
Work in connection with changes in underground structures,	2,357 71	
Additional expenses,	1,417 48	
		$36,810 59
Section 38.		
Pipes and special castings,	$1,656 27	
Day work, labor,	16,607 20	
Day work, supplies and expenses,	14,977 03	
Additional expenses,	738 04	
		33,978 54
Engineering and preliminary, sections 37 and 38,		4,167 63
Total,		$74,956 76

PUMPING ENGINE FOR SOUTHERN HIGH SERVICE.

A contract for building and erecting a triple expansion, crank and fly-wheel engine, having a capacity of 40,000,000 gallons in twenty-four hours, was made with the Holly Manufacturing Company of Buffalo, on September 21, 1909, and the construction of the engine was begun at the shops of the contractor in the latter part of that year. The first shipment of parts of the engine arrived at the pumping station in the latter part of August, 1910, and the work of erection has been in progress since that date. At the close of the year the main parts of the engine were nearly all in place, and it appears probable that the engine will be ready for service on March 21, 1911, as specified in the contract.

This engine is to be used for pumping water for the southern high-service district, but it is located in the low-service station in space which was originally designed to be used for engines pumping to the highest portions of Newton, Brookline and West Roxbury.

On April 29 a contract was made with the Robb-Mumford Boiler Company of South Framingham for furnishing two vertical fire-tube boilers from designs made by F. W. Dean of Boston, mechanical engineer. One of these boilers was delivered at the pumping station on December 29 and the other will be delivered early in January. Each boiler is of 300 nominal horse power, 9 feet 1⅞ inches in diameter, and contains 484 No. 12 gage, 2-inch charcoal iron tubes 15 feet long.

A contract for constructing and erecting a fuel economizer, containing 144 cast-iron tubes 4 inches in diameter, was made on October 11 with the B. F. Sturtevant Company of Hyde Park for the sum of $1,740. The economizer has been delivered at the station and is now being erected.

Grates for use with the boilers are to be furnished by the New England Roller Grate Company for $225 each.

A steel plate smoke flue, to connect the new boilers with the economizer and chimney, has been ordered from the B. F. Sturtevant Company for the sum of $536.

The work of building the concrete foundations for the engine and boilers, constructing a valve chamber 38 feet x 9 feet at the front of the pumping station to receive two 36-inch hydraulic lift valves, cutting out the opening in the engine room floor to receive the engine and the openings in the concrete foundation walls for the suction and delivery mains, has been done by the maintenance force of the department.

The foundation for the engine was built in June and consists of a block of concrete masonry 33 feet 8 inches long, 21 feet 8 inches wide and 7 feet 6 inches deep. The concrete rests upon a clayey hardpan. The iron bolts securing the engine to this foundation are attached to cast-iron washers 18 inches square, embedded in the concrete 5 feet 11 inches from the top of the foundation. The concrete was mixed in the proportion of 1 part cement, 3 parts sand and 6 parts broken stone, and large pieces of broken concrete and rock from the excavation were embedded in the foundation.

A foundation was also built for one of the boilers, that for the other having been constructed when the pumping station was built. This foundation was carried 13 feet 2 inches below the boiler room floor. The concrete was mixed in the proportion of 1 part cement, 6 parts sand and 12 parts broken stone for 6 feet above the bottom, and the upper 7 feet was made of 1 part cement, 2 parts sand and 6 parts stone.

HYDRO-ELECTRIC PLANT.

Specifications were prepared in May for the sale of the electrical energy to be developed at the Wachusett Dam at Clinton, and bids for the energy were received on June 15, but it was not until September 14 that a contract was made with the Connecticut River Transmission Company for the purchase of all the energy for a term of five years from July 1, 1911.

Proposals for the construction and installation of the hydro-electric machinery required for the development of the power were received on November 9, and a contract has been made with the S. Morgan Smith Company of York, Pa., for installing both the hydraulic turbines and the electric generators. The generators and other electrical equipment will be furnished under a subcontract by the Westinghouse Electric & Manufacturing Company of Pittsburgh, Pa.

A contract for furnishing a traveling crane for use in erecting and maintaining the machinery has been made with the Niles-Bement-Pond Company of Boston, and a contract for furnishing four 48-inch hydraulic lift valves has been awarded to the Fairbanks Company of Boston.

The completed plant is to include four 1,200 horse power hydraulic turbine units of the spiral case, horizontal shaft type, each directly coupled to a 1,000-kilowatt, 60-cycle, 3-phase, 13,800-volt, alternating current generator, together with two 90 horse power horizontal shaft turbines, each directly coupled to a 60-kilowatt direct current, 125-volt generator, to be used in exciting the main generators. It is expected that this plant will be completed in readiness for operation by July 1 of the coming year.

MISCELLANEOUS CONSTRUCTION.

The Coffin Valve Company, under a contract made May 17, has furnished five 36-inch hydraulic lift valves for $1,272 each, for use in connection with the new pumping engine at Chestnut Hill, also seven 24-inch and two 16-inch screw lift valves for use with the pipe lines. Fourteen sets of steelwork for covering valve chambers have been furnished by the James Russell Boiler Works for the sum of $690, and four steel chambers for Venturi meter registers have been furnished by the Daniel Russell Boiler Works for $175 each.

ENGINEERING.

The work of the engineering force in connection with construction has included the preparation of plans and specifications, and the superintendence of work which has been in progress under 25 separate contracts, aggregating about $700,000. The principal items of work covered by these contracts have been the 60-inch pipe line and tunnel in Newton; the new pumping engine, boilers and accessories at the Chestnut Hill pumping station; the 36-inch pipe line and tunnel from Chelsea to East Boston; pipe lines in Arlington and Lynn, and a hydro-electric power plant at the Wachusett Dam. During the year investigations have been made and estimates prepared relative to furnishing a supply of water from the Metropolitan Works to the towns of Peabody, Wakefield and Hyde Park.

MAINTENANCE.

RAINFALL AND YIELD.

The rainfall on the Wachusett watershed was 37.85 inches and on the Sudbury watershed 35.64 inches. In each case the amount is the mean of observations made at four stations. The rainfall for the past year on the Sudbury watershed has been less than that in any previous year during the thirty-six years covered by the records, with the exception of 1883, when it was 32.78 inches, and the rainfall of the past three years has been but 113.54 inches, which is less than that for any corresponding length of time since the records were commenced.

The daily average yield of the Wachusett watershed was but 828,000 gallons per square mile per day, which is less than any previous record, and 29 per cent. less than the average yield during the previous thirteen years. The average daily yield per square mile during the last six months of the year was but 201,000 gallons, or 16 per cent. below the lowest previous record for the watershed, and 65 per cent. below the average yield of the driest six months during the past fourteen years.

Statistics relating to the rainfall and yield of watersheds may be found in Appendix No. 2, tables Nos. 1 to 8.

STORAGE RESERVOIRS.

The quantity stored in all the storage reservoirs on January 1, 1910, was 62,101,500,000 gallons. There was a loss of 543,400,000 gallons during the first five days of the year, after which time there was a practically continuous gain until the first of April, when the quantity stored in all the reservoirs was 77,692,400,000 gallons. The quantity stored was reduced to 76,719,700,000 gallons on April 18, after which time it was increased until May 10, when it was 77,826,500,000 gallons. It fell to 76,585,000,000 gallons on June 5, and rose to 77,676,600,000 gallons on June 19, after which time there was a practically continuous loss of storage until the end of the year.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month: —

Quantity of Water stored in Wachusett Reservoir, and in Reservoirs on Sudbury and Cochituate Watersheds, at the Beginning of Each Month.

DATE.	In Wachusett Reservoir (Gallons).	In Sudbury Reservoir and Framingham Reservoir No. 3 (Gallons).	In All Other Storage Reservoirs (Gallons).	Total (Gallons).
1910.				
January 1,	48,667,800,000	7,806,400,000	5,627,300,000	62,101,500,000
February 1,	52,256,200,000	7,857,400,000	6,258,900,000	66,372,500,000
March 1,	56,059,900,000	8,237,100,000	6,632,400,000	70,929,400,000
April 1,	63,252,000,000	8,046,800,000	6,393,600,000	77,692,400,000
May 1,	63,612,300,000	8,308,300,000	5,980,400,000	77,901,000,000
June 1,	62,932,400,000	7,933,900,000	6,196,300,000	77,062,600,000
July 1,	62,812,600,000	7,918,800,000	5,841,400,000	76,572,800,000
August 1,	59,194,200,000	7,962,900,000	5,685,300,000	72,842,400,000
September 1,	56,136,200,000	7,906,200,000	5,611,500,000	69,653,900,000
October 1,	53,360,500,000	7,831,100,000	5,665,700,000	66,857,300,000
November 1,	50,146,000,000	7,761,200,000	5,613,700,000	63,520,900,000
December 1,	48,175,400,000	7,808,500,000	5,700,700,000	61,684,600,000
1911.				
January 1,	45,610,400,000	7,890,400,000	5,826,200,000	59,327,000,000

Wachusett Reservoir and Dam. — At the beginning of the year the water in this reservoir was 12.91 feet below high-water mark, and the reservoir contained 48,667,800,000 gallons of water. The low-water mark of the early part of the year was on January 6, when the elevation of the reservoir was 381.70. After January 18 there was an almost continuous rise in the elevation of the water level of the reservoir until about April 1, when it was 393.72, or 1.28 feet below high-water mark. From this time until the latter part of June the reservoir surface remained at about the same elevation, the highest point being reached on May 8, when it was 394.25. After June 20 the reservoir surface lowered at the rate of a little more than 2 feet per month until the end of the year, when it stood at elevation 379.35, and contained 45,610,400,000 gallons of water, showing a net loss in storage during the year of 3,057,400,000 gallons.

The average daily quantity discharged from the reservoir into the river, in accordance with the requirements of section 4 of chapter 488 of the Acts of the year 1895, was 2,106,000 gallons per day.

As in previous years, the action of the waves on the shores of the reservoir has made necessary the removal of soil, in order to prevent its being washed into the reservoir. Between Hastings Cove in Boylston and Pine Hill in West Boylston, on the south shore, and along the north shore at Beaman Hill in West Boylston, the soil has been removed at points where necessary for a total distance of 5,526 feet, in widths varying from 10 to 25 feet. The aggregate area from which soil was removed was 1.75 acres, as compared with 1.46 acres in 1909. The amount expended for this work was $907.29.

The action of the flood waters during the spring washed out the gravel bank which formed the easterly shore at the head of the Stillwater Basin. For a distance of 300 feet the bank has been regraded and reinforced with riprap formed with stones and gravel taken from the bed of the basin. The amount expended for this work was $258.36.

The riprap on the easterly shore of the reservoir immediately above the dam has been repaired and reinforced with heavier stones for a distance of 1,250 feet, at a cost of $115.16.

The paving at the outlet of the culvert which carries a small brook under Beaman Street into the Stillwater Basin has been relaid where damaged by the wearing away of the shore.

Tree stumps, roots, logs and miscellaneous dêbris brought into the reservoir by the flood waters in the spring, or unearthed by wave action on the shores, have been collected and burned.

Two pot holes, located near the westerly end of the North Dike, between the Clinton and West Boylston highway and the Worcester, Nashua & Portland Railroad, which became stagnant pools when the reservoir was full, have been improved in appearance, one by filling with earth to a level about one foot above high water in the reservoir and the other by cleaning the shores.

The standing and rowen grass on about 350 acres of land was sold for $2,605.75. About 6.4 acres of grass land below the dam and 17.6 acres on the back slope of the easterly portion of the North Dike have been fertilized with 620 cubic yards of sludge collected from the settling tanks at the Clinton sewerage filter-beds. The cost of hauling and spreading this material was $643.82.

The motor scow, which was built in 1909, has been used nearly every day, when the reservoir was not covered with ice, for transporting men, tools and materials in connection with the maintenance work, and has given excellent satisfaction.

The structures and grounds at the dam are in good condition. The outside and inside woodwork of both the upper and lower gate-chambers, the iron fences and railing on and about the dam, and the cast-iron and steel flashboard supports on the dam have been painted. A fountain has been installed in the pool below the dam, from which is discharged a portion of the water which the law requires shall be discharged into the river, thus adding a beautifying feature to the grounds.

The old dam at the outlet of Middle Waushacum Pond has been replaced with a concrete structure 26½ feet long and 8 feet high, having a spillway 12 feet long fitted to receive stop-planks, and a 3 foot by 3½ foot sluiceway fitted with a sluice gate.

The brook channel below this dam has been straightened, cleaned and improved for a distance of about 375 feet.

All the buildings at the storage yard near the Wachusett Dam, also the exterior of six houses owned by the Board located near the Clinton sewerage filter-beds, have been given two coats of paint.

Sudbury Reservoir. — All the water supplied to the Metropolitan District from the Wachusett Reservoir passes through this reservoir, and its level is controlled by the manipulation of the gates controlling the flow through the Wachusett Aqueduct. The surface of the reservoir did not fall below the crest of the dam during the year, and all the water drawn from this reservoir into Framingham Reservoir No. 3 passed over the crest of the dam, except from April 15 to May 7, when the flashboards were on the whole length of the crest and the water was drawn through one of the waste gates.

The Bigelow house on Farm Street, Marlborough, occupied by one of the section men, has been repaired and painted. In order to obtain a permanent supply of water for the use of the section man living in the Cratty house, at Fayville, a well has been dug near the shore of the reservoir and connected with the house by a 1½-inch cement-lined pipe 215 feet in length. Some grading has been done on the road, following the north shore of the reservoir, from the dam around Pine Hill to Parmenter Street, and two culverts have been constructed in connection with this work. The reservoir and grounds have received the customary care and attention and are in good condition.

Framingham Reservoir No. 3. — The water in this reservoir was maintained within about 2 feet of the stone crest of the overflow. Some water was wasted into Framingham Reservoir No. 1 during the first three days of March, and also during the latter part of March and the first part of April.

Seven horizontal joints and a portion of the vertical joints in the face of the overflow of the dam, and ten horizontal and twenty-eight vertical joints on the down-stream face of the gate-house over the 48-inch pipes leading to Framingham Dam No. 1, have been cut out and repointed with Portland cement mortar. The mortar in many of the joints was found to be disintegrated to a considerable depth, necessitating cutting out the joints to depths of from 8 to 18 inches.

The entrance driveway at the dam has been extended to the new location of Worcester Street. The area between the old and new location of the street has been graded and covered with loam, and a gravel sidewalk has been built bordering on the street.

Framingham Reservoirs Nos. 1 and 2. — No water was drawn from these reservoirs during the year for the use of the Metropolitan District.

Ashland, Hopkinton and Whitehall Reservoirs. — These reservoirs have not been drawn upon for the supply of the District during the year, and have remained at or near high-water mark. The grounds have received the usual care and are in good condition. The attendant's house at Hopkinton Reservoir has been repaired and the exterior painted. At Whitehall Reservoir the upper portion of the temporary dam built by the city of Boston in 1897, for the purpose of providing additional storage, has been removed, as it had become badly decayed and is no longer required.

Farm Pond. — No water was drawn from the pond for use in the Metropolitan District; none was wasted from the pond and none run into it from the Sudbury River. The town of Framingham drew the greater portion of its supply from the filter-gallery alongside the pond, but during 258 days of the year drew a portion of its supply directly from the Sudbury Aqueduct. The total quantity used in the town was 228,700,000 gallons, of which 38,100,000 gallons were drawn directly from the Sudbury Aqueduct.

Lake Cochituate. — The water in the lake was at elevation 138.76, or 5.6 feet below high water, at the beginning of the year. It rose to elevation 143.33 on February 10, when the waste gate was opened and the water prevented from rising. About the middle of April the quantity wasting was increased, and the lake surface lowered about 2 feet, and in the latter part of June and early in July the lake was lowered about 18 inches more, to elevation 139.50, for the purpose of facilitating the construction of a drainage system near the lake. The water was maintained at this elevation until the first of November, after which time it rose slowly and stood at elevation 141.17 at the end of the year. No water was drawn from the lake for the use of the Metropolitan District during the year.

The coping of the retaining wall bordering the driveway from Lake Avenue to the effluent gate-house, a distance of about 700 feet, has been reset, and the upper part of the retaining wall along Lake Avenue, for a distance of 400 feet west of the entrance driveway, relaid. The iron and wood work at the outlet dam, and the exterior of the roof and ironwork in the interior of the effluent gate-house, have been painted.

A four-strand wire fence, 281 feet long, has been built on the line between property of Edward Hammond and the Commonwealth on the east side of the lake, near Camp Tray. Twenty-nine standard land bounds have been set to define land of the Commonwealth along Course Brook north of Speene Street.

Considerable work was done during the winter months in cleaning up woodland around the lake by removing dead and broken limbs, cutting brush, thinning out trees, and in clearing a strip from 4 to 5 feet in width through the woods along property lines.

DIVERSION OF SURFACE DRAINAGE OF THE VILLAGE OF COCHITUATE, FROM LAKE COCHITUATE INTO THE SUDBURY RIVER.

The surface drainage from an area of 140 acres now draining through Snake Brook into Lake Cochituate, on which there is a population of 707, is to be diverted into a system of open and covered drains, by which it is to be carried outside the watershed and discharged into Bannister's Brook. The outlet of the system is at an old mill-pond located north of the County Road and west of Speene Street, in Framingham. The open channel extends southerly from this point along Bannister's Brook, crossing the County Road, then turning easterly, following an old channel known as Richardson's drain, crossing Speene Street near the Natick-Framingham boundary line and the Saxonville Branch of the Boston & Albany Railroad, through land of the Commonwealth to a point near Lake Avenue in Natick, 400 feet west of the culvert connecting the northern and middle divisions of Lake Cochituate.

The length of this open channel is 5,958 feet, including 82 feet of covered concrete culvert at two street crossings. The channel is 12 inches wide at the bottom, with side slopes of 2 horizontal to 1 vertical, and is constructed with a plank bottom formed by spiking two 2-inch x 7-inch spruce planks side by side on 3-inch x 4-inch sills, 2 feet long, spaced 4 feet on centres, with side pieces of 6-inch x 6-inch spruce cut on the diagonal and rabbetted so as to lay 1 inch over the bottom planks. These side pieces form a footing for a strip of cobblestone paving 1½ feet wide on the slope, excepting at the outside of all curves, where the paving is 4½ feet wide. The slopes for a distance of 3 feet above the paving are covered with coarse gravel, excepting at the outside of curves.

The concrete-covered drain extends from the upper end of the open channel through Lake Avenue, in Natick, Pond Street, in Wayland, and land of the Commonwealth on the southerly side of Pond Street, to Hammond's Brook, a distance of 3,454 feet. This drain is 36 inches wide x 33 inches high, and is constructed of Portland cement concrete mixed in the proportion of 1 part cement, 2½ parts sand and 5 parts gravel.

At the crossing of the culvert connecting the northerly and middle divisions of Lake Cochituate a 36-inch cast-iron pipe is used in place of the concrete structure. This pipe was laid by the maintenance force in 1909, in order to take advantage of the unusually low level of the water in the lake.

A 24-inch vitrified pipe extends from the inlet chamber at Hammond's Brook through land of the Commonwealth, a distance of 957 feet, to Main Street, in Wayland. Nine manholes were built on the line of the concrete and pipe drains and 14 catch basins were built to receive the surface drainage at different points. In connection with the catch basins there were laid 167.5 feet of 18-inch and 351.4 feet of 12-inch vitrified pipe.

Contract work was begun July 12, the open channel was completed on December 3, and at the close of the year about two weeks' work remained to complete the drains in readiness for use. The average force employed by the contractor on the work was 64 men and 7 horses. The largest force employed was during the week ending September 10, when 134 men and 10 horses were at work.

The value of the work done under this contract to December 31 was $30,674.52, and the total cost of the whole work will be about $32,000.

SOURCES FROM WHICH WATER FOR THE SUPPLY OF THE METROPOLITAN DISTRICT HAS BEEN TAKEN.

An average of 103,146,200 gallons of water per day was drawn from the Wachusett Reservoir through the Wachusett Aqueduct into the Sudbury Reservoir. For the use of the Metropolitan District an average of 28,974,000 gallons per day was drawn from the Sudbury Reservoir through the Weston Aqueduct and an average of 85,033,000 gallons per day from Framingham Reservoir No. 3 through the Sudbury Aqueduct.

The drainage area of Spot Pond furnished 57,000 gallons of water per day.

AQUEDUCTS.

The *Wachusett Aqueduct* was in use 8,163 hours and 20 minutes, equivalent to 340.1 days, during the year. The aqueduct was not cleaned during the year.

The *Sudbury Aqueduct* was in continuous service the entire year, the daily flow to Chestnut Hill Reservoir averaging 85,033,000 gallons. The joints in the brick masonry and in the sandstone trimmings of the superstructures of Bacon's and Fuller's waste-weirs have been repointed with Portland cement mortar, also the joints in the stone masonry of the culverts numbered 16, 34, 39, 40 and 41. The joints in the masonry substructure of Clark's waste-weir and of the stone walls on both sides of the channel leading to Culvert No. 34 were also repointed.

At Echo Bridge, over the Charles River, the face of the ledge on the east side of the river at the foot of the large arch had commenced to disintegrate, and thus render unsafe the supports for the platform used by the public when listening to the echo. In order to prevent further disintegration of the rock a rubble wall about 5 feet high, with an average thickness of 3½ feet at the bottom, has been built, covering the whole face of the ledge under the arch. About 13 cubic yards of material were used in the construction of this wall.

The leakage through joints and cracks in the masonry of this bridge is increasing from year to year, due to the gradual widening of the cracks by temperature changes and the action of ice during the winter, and extensive repairs similar to those made a few years ago at the Waban Bridge will soon be required.

The exterior of the store-house near the west siphon chamber, the floor grating in Fuller's waste-weir, the iron railing and roof flashing at the east siphon chamber, the railings, beams and other ironwork in the stairways leading to the top of Echo Bridge and to the platform under the large arch, and the manhole covers along the aqueduct line have been painted, and the stairways on the embankments of the east and west siphon chambers and on that leading to the top of Echo Bridge have been oiled. A new right-of-way has been acquired from Eliot Street, in Natick, to Bacon's waste-weir, to be used in place of the old inconvenient right-of-way from Woodland Street.

No water was drawn through the *Cochituate Aqueduct* for the use of the Metropolitan District during the year. The joints in the stone masonry of the following culverts have been cut out and repointed: Culvert west of Croton Street, in Wellesley; culvert east of Washington Street, at Newton Lower Falls; culvert on the west side of Woodward Street, in Newton, and the first culvert east of Chestnut Street, in Newton.

The *Weston Aqueduct* was in continuous service throughout the year, the daily average flow being 28,974,000 gallons. The aqueduct was not cleaned during the year. The siphon pipe over the Sudbury River, the iron and wood work in the gaging and siphon chambers and the manhole covers have been painted. At several points along the line of the aqueduct the slopes of the embankments have been graded and seeded.

Pumping Stations.

Seventy-four per cent. of the water supplied to the Metropolitan District has been pumped at the two stations at Chestnut Hill Reservoir, and the remainder has been delivered by gravity. The total quantity pumped at all the stations was 34,108,790,000 gallons, which was 4.62 per cent. less than during the preceding year. The cost of operating the stations was $101,996.34, equivalent to $2.99 per million gallons pumped, which was almost exactly the same as the corresponding amount for the year 1909. The average cost of raising 1,000,000 gallons of water 1 foot high at all the stations was $0.0342, which is slightly less than the cost during the previous year. Coal for use at the several stations has been purchased as follows: —

By whom furnished.	Gross Tons.					Cost per Gross Ton, in Bins.[1]
	Chestnut Hill High-service Station.	Chestnut Hill Low-service Station.	Spot Pond Station.	Arlington Station.	West Roxbury Station.	
Gorman-Leonard Coal Company, bituminous,	1,015.09	-	-	-	-	$4 09
Gorman-Leonard Coal Company, bituminous,	-	569.60	-	-	-	4 01
Spring Coal Company, bituminous,	2,787.74	-	-	-	-	3 96
Spring Coal Company, bituminous,	-	1,508.35	-	-	-	3 79
C. W. Claflin & Co., buckwheat anthracite,	268.78	-	-	-	-	2 80
C. W. Claflin & Co., buckwheat anthracite,	903.40	-	-	-	-	2 75
C. W. Claflin & Co., buckwheat anthracite,	-	115.92	-	-	-	2 63
C. W. Claflin & Co., buckwheat anthracite,	-	813.67	-	-	-	2 58
New England Coal & Coke Company, bituminous.	-	-	587.77	-	-	4 88
New England Coal and Coke Company, bituminous.	-	-	58.34	-	-	4 60
Locke Coal Company, bituminous,	-	-	90.07	-	-	4 60
Locke Coal Company, screenings,	-	-	149.06	-	-	2 50
Joseph Butler, screenings,	-	-	69.30	-	-	2 50
New England Coal and Coke Company, bituminous.	-	-	-	170.00	-	4 31
New England Coal and Coke Company, bituminous.	-	-	-	30.09	-	4 06
New England Coal and Coke Company, bituminous.	-	-	-	124.42	-	3 99
Philadelphia and Reading Coal and Iron Company, screenings.	-	-	-	117.50	-	2 66
Metropolitan Coal Company, furnace,	-	-	-	-	20.04	6 27
Roxbury Coal Company, furnace,	-	-	-	-	6.77	5 85
Metropolitan Coal Company, pea,	-	-	-	-	181.84	5 04
Roxbury Coal Company, buckwheat anthracite,	-	-	-	-	104.02	4 37
Roxbury Coal Company, buckwheat anthracite,	-	-	-	-	1.86	3 96
Total gross tons, bituminous,	3,802.83	2,077.95	736.18	324.51	-	-
Total gross tons, anthracite,	1,172.18[2]	929.59[2]	-	-	314.53	-
Total gross tons, anthracite screenings,	-	-	218.36	117.50	-	-
Average price per gross ton, bituminous,	$3 99	$3 85	$4 82	$4 13	-	-
Average price per gross ton, anthracite,	2 76[2]	2 59[2]	-	-	$4 91	-
Average price per gross ton, anthracite screenings,	-	-	2 50	2 68	-	-

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[1] Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.

[2] Buckwheat.

The contracts which have been made for bituminous coal have specified that the coal should contain approximately 14,700 British thermal units per pound, 18 to 20 per cent. volatile matter, and not more than 7 per cent. of ash and 1 per cent. of sulphur. Payments for the coal are now made on the basis of the price bid, corrected for variations in heating value and per cent. of ash, as determined by testing samples of the coal delivered, an addition being made in cases where the number of British thermal units exceeds 14,700 and a deduction when the number falls below 14,600. A deduction is also made when the moisture in the coal exceeds 3 per cent. These requirements are more stringent than those in force during previous years, and the quality of the coal now obtained is better than it was a few years ago.

The following table shows the results of tests made of coal burned at the Water Works pumping stations during the past year: —

KIND OF COAL.	Number of Samples tested.	British Thermal Units.	Percentage of Volatile Matter.	Percentage of Ash.	Percentage of Moisture.
Vulcan,	58	14,474	20.95	8.16	2.54
Beaver Run,	26	14,722	17.40	6.70	3.15
New River,	7	14,867	21.18	5.27	1.83
Pocahontas,	6	14,879	19.55	5.16	2.33
Georges Creek,	6	14,469	18.88	7.71	2.59
Davis,	2	14,517	17.12	7.08	2.48
Nan-ty-glo,	1	14,982	21.56	5.14	3.24
Carbon,	1	14,268	18.10	9.24	4.17

Chestnut Hill High-service Station.

At this station water is pumped for use in the high-service district of Boston, the city of Quincy and the towns of Watertown, Belmont and Milton.

The following are the statistics relating to operations at this station: —

	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Totals for Station.
Total quantity pumped (million gallons),	1,377.71	228.67	10,824.70	12,431.08
Daily average quantity pumped (gallons),	3,775,000	626,000	29,657,000	34,058,000
Total coal used (pounds),	2,168,024	247,119	8,467,877	10,883,020
Gallons pumped per pound of coal,	635.47	925.34	1,278.33	1,142.25
Average lift (feet),	119.67	129.88	130.58	129.36
Cost of pumping: —				
Labor,	$4,005 32	$538 35	$16,990 32	$21,533 99
Fuel,	3,605 96	411 62	14,209 11	18,226 69
Repairs,	337 91	42 36	1,336 95	1,717 22
Oil, waste and packing,	99 32	13 35	421 33	534 00
Small supplies,	66 32	8 91	281 31	356 54
Totals,	$8,114 83	$1,014 59	$33,239 02	$42,368 44
Cost per million gallons pumped,	$5.8900	$4.4370	$3.0710	$3.4080
Cost per million gallons raised 1 foot high,	.0492	.0342	.0235	.0263

The daily average quantity pumped was less than the corresponding quantity for the previous year by 2,750,000 gallons, or 7.47 per cent.

The cost of operating the station was $4,110.21 less than for the previous year, due largely to the reduction in the quantity pumped.

Chestnut Hill Low-service Station.

The daily average quantity pumped at this station was less by 2,161,000 gallons, or 4.11 per cent., than the corresponding amount for the previous year.

The following are the statistics relating to operations at this station: —

	Engines Nos. 5, 6 and 7.
Total quantity pumped (gallons), ...	18,394,520,000
Daily average quantity pumped (gallons), ...	50,396,000
Total coal used (pounds), ...	7,122,390
Gallons pumped per pound of coal, ...	2,582.63
Average lift (feet), ...	49.08

Cost of pumping: —	
Labor, ...	$19,675 97
Fuel, ...	10,952 56
Repairs, ...	1,525 11
Oil, waste and packing, ...	472 54
Small supplies, ...	363 89
Total for station, ...	$32,990 07
Cost per million gallons pumped, ...	$1.7930
Cost per million gallons raised 1 foot high, ...	.0365

The work of building foundations for the new engine and boilers which are being installed at this station has been in progress during the year. A description of this work will be found in this report under the head of " Construction."

Spot Pond Pumping Station.

The following are statistics relating to operations at this station: —

Total quantity pumped (gallons), ...	2,752,110,000
Daily average quantity pumped (gallons), ...	7,540.000
Total coal used (pounds), ...	2,413,914
Gallons pumped per pound of coal, ...	1,140.10
Average lift (feet), ...	130.92
Engine No. 8 operated (hours), ...	161
Engine No. 9 operated (hours), ...	3.218
Quantity pumped by Engine No. 8 (gallons), ...	70.130,000
Quantity pumped by Engine No. 9 (gallons), ...	2,681,980.000

Cost of pumping: —	
Labor,	$8,779 04
Fuel,	4,191 43
Repairs,	199 22
Oil, waste and packing,	249 39
Small supplies,	203 39
Total for station,	$13,622 47
Cost per million gallons pumped,	$4.9500
Cost per million gallons raised 1 foot high,	.0378

The quantity of water pumped at this station was 2.2 per cent. greater, while the total cost of operating the station was $426.39. or 3 per cent. less than during the previous year. The reduction in cost was due to the fact that but $199.22 were expended for repairs during the past year, as compared with $686.99 during 1909. The cost per million gallons pumped to the reservoir was $4.95, as compared with $5.216 in 1909.

Arlington Pumping Station.

At this station was pumped all the water supplied to the town of Lexington, to the high-service district of the town of Arlington and to a few houses in the town of Belmont.

The following are the statistics relating to operations at this station: —

Total quantity pumped (gallons),	282,530,000
Daily average quantity pumped (gallons),	774,000
Total coal used (pounds),	999.115
Gallons pumped per pound of coal,	282.78
Average lift (feet),	285
Engine No. 10 operated (hours),	6,295
Engine No. 11 operated (hours),	220
Quantity pumped by Engine No. 10 (gallons),	275,440,000
Quantity pumped by Engine No. 11 (gallons),	7,090,000

Cost of pumping: —	
Labor,	$5,029 26
Fuel,	1,658 48
Repairs,	294 29
Oil, waste and packing,	101 45
Small supplies,	300 04
Total for station,	$7,383 52
Cost per million gallons pumped,	$26.1340
Cost per million gallons raised 1 foot high,	.0917

There was an increase of 17.08 per cent. in the quantity pumped, and a decrease of $442.80, or 5.66 per cent., in the cost of operating the station, as compared with the previous year.

The efficiency of the plant has been improved by the installation of a feed-water heater which had been used previously at the Chestnut Hill station.

West Roxbury Pumping Station.

At this station water was pumped for supplying the higher portions of West Roxbury and Milton.

The following are the statistics relating to operations at this station: —

Total quantity pumped (gallons),	248,551,000
Pumps operated 7,654 hours; average, 21 hours per day.	
Daily average quantity of water pumped (gallons),	681,000
Daily average quantity of coal consumed (pounds),	1,913
Gallons pumped per pound of coal,	355.92
Average lift (feet),	134
Cost of pumping: —	
Labor,	$3,775 22
Fuel,	1,553 38
Repairs,	211 87
Oil, waste and packing,	41 06
Small supplies,	50 31
Total for station,	$5,631 84
Cost per million gallons pumped,	$22.6590
Cost per million gallons raised 1 foot high,	.1691

The quantity pumped was 18.95 per cent. greater while the cost of operating the station was less by $744.63, or 11.68 per cent., than for the previous year. The cost per million gallons pumped was reduced from $30.52 to $22.66. This result was very largely due to the use of a fuel of lower cost and to the more efficient operation of the machinery.

CONSUMPTION OF WATER.

The daily average quantity of water consumed in the 18 municipalities supplied from the Metropolitan Water Works during the year 1910, as measured by Venturi meters, was 112,092,100 gallons, equal to 110 gallons per capita in the district supplied. In addition to the above, 85,400 gallons daily were supplied to the United States Government reservation on Peddock's Island, and 16,500 gallons daily to a small portion of the town of Saugus. The daily average quantity supplied to the Metropolitan Water District, as determined by pump measurement and by the flow in the Weston Aqueduct, and the estimated yield of Spot Pond, was 113,880,000 gallons, equal to 111 gallons per inhabitant. The excess difference of 1,686,000 gallons per day between the quantity delivered by the aqueducts and that measured by meters to the several municipalities is due to difference in methods of measurement, to leakage from the Metropolitan Water Works reservoirs and pipes, and to the use of water at the Chestnut Hill and Spot Pond pumping stations.

The daily average consumption of water in each of the cities and towns supplied from the Metropolitan Works during the years 1909 and 1910, as measured by meters, was as follows: —

	Estimated Population, 1910.	Daily Average Consumption.					
		1909.		1910.		Increase in Gallons.	Decrease in Gallons.
		Gallons.	Gallons per Capita.[1]	Gallons.	Gallons per Capita.		
Boston, . . .	674,400	94,029,900	143	87,346,700	130	-	6,683,200
Somerville, . . .	77,640	6,331,000	83	6,189,500	80	-	141,500
Malden, . . .	44,730	1,848,500	43	1,874,400	42	25,900	-
Chelsea, . . .	32,540	2,869,400	89	2,834,500	87	-	34,900
Everett, . . .	33,710	2,641,300	80	2,575,600	76	-	65,700
Quincy, . . .	32,870	2,919,000	91	2,891,900	88	-	27,100
Medford, . . .	23,330	1,732,300	77	1,422,400	61	-	309,900
Melrose, . . .	15,790	962,300	62	1,005,700	64	43,400	-
Revere, . . .	18,500	1,250,700	72	1,313,400	71	62,700	-
Watertown, . .	12,960	755,300	60	880,800	68	125,500	-
Arlington, . . .	11,270	861,300	79	938,200	83	76,900	-
Milton, . . .	7,970	313,200	40	309,200	39	-	4,000
Winthrop, . . .	10.290	877,600	91	649,500	63	-	228,100
Stoneham, . . .	7,130	575,200	82	650,800	91	75,600	-
Belmont, . . .	5,600	310,100	58	329,500	59	19,400	-
Lexington, . . .	4,440	329,400	76	345,500	78	16,100	-
Nahant, . . .	2,100	124,400	60	121,700	58	-	2,700
Swampscott, . .	6,960	388,200	56	412,800	59	24,600	-
District, . .	1,022,230	119,119,100	119	112,092,100	110	-	7,027,000

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[1] The populations for 1909 were revised after the Census of 1910 became available, and consequently the per capita figures differ from those published in 1909 report.

The consumption in the several districts was as follows: —

	Gallons per Day. 1910.	Decrease (Gallons per Day).	Percentage of Decrease.
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, .	44,667,600	3,668,000	7.59
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston, ...	26,032,400	499,100	1.88
Southern high-service district, embracing the high-service districts of Boston, Quincy, Watertown, and portions of Belmont and Milton, ...	32,644,400	2,985,000	8.38
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, ...	7,292,600	101,200	1.37
Southern extra high-service district, embracing the higher portions of West Roxbury and Milton, ...	681,000	108,500[1]	18.95[1]
Northern extra high-service district, embracing Lexington and the higher portions of Arlington and Belmont, ...	774,100	117,800[1]	17.95[1]
Totals, ...	112,092,100	7,027,000	5.90

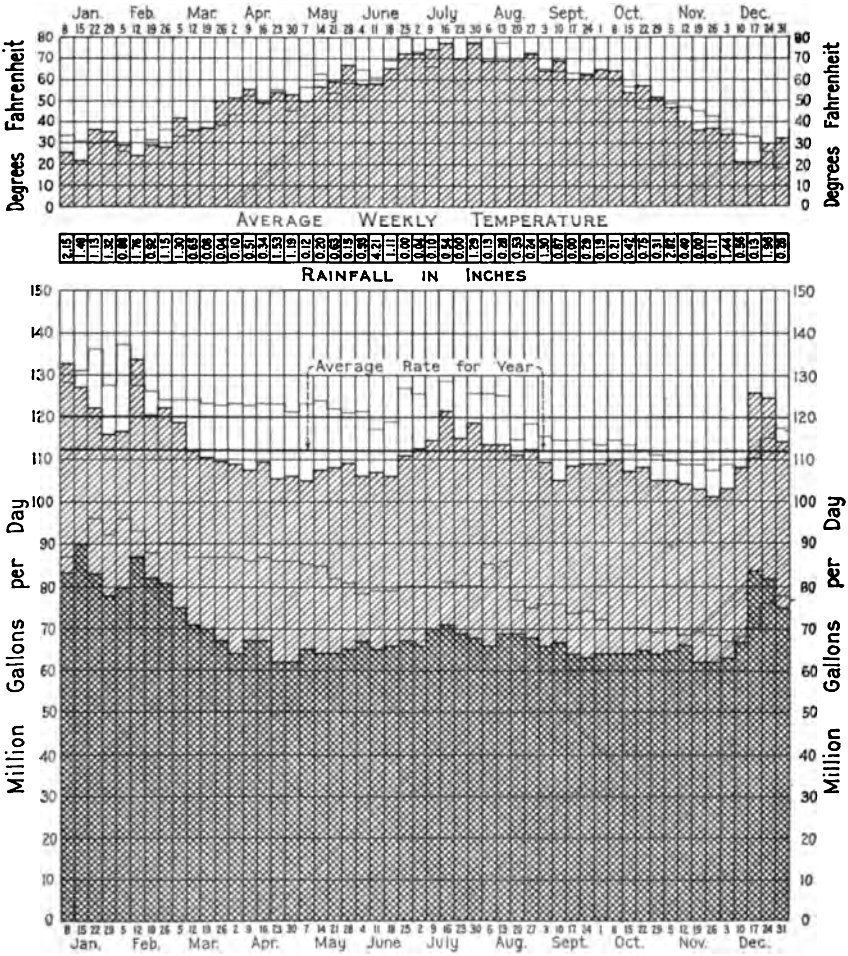
[1] Increase.

The daily average quantity of water used in the District was 13,332,100 gallons less than during the year 1908. In the cities of Boston and Medford and the town of Winthrop a large reduction in the use of water has been accomplished during the past year by the introduction of meters. The reduction in these places, together with Melrose, in which meters were introduced in 1906 and 1907, illustrates very forcibly the saving which has been accomplished largely by the introduction of meters: —

City or Town.	Population, 1910.	Per Capita Consumption (Gallons).			Equivalent Saving in Gallons per Day.	Meters in Use.	
		1907.	1910.	Reduction in Three Years.		Jan. 1, 1907.	Jan. 1, 1910.
Boston, ...	674,400	157	130	27	18,208,800	5,090	12,100
Medford, . . .	23,330	105	61	44	1,026,520	449	2,594
Melrose, ...	15,790	118	64	54	852,660	132	3,510
Winthrop, . . .	10,290	117	63	54	555,660	45	1,533
Totals, . . .	723,810				20,643,640	5,716	19,737

The diagram facing this page shows graphically the average daily consumption and the rate of consumption between the hours of 1 and 4 A.M. in the district supplied by the Metropolitan Works for

AVERAGE RATE OF CONSUMPTION
IN
METROPOLITAN WATER DISTRICT
AND
RAINFALL AND AVERAGE TEMPERATURE OF AIR AT CHESTNUT HILL RESERVOIR
FOR
EACH WEEK DURING 1910



Average Rate of Consumption for each week, thus .... ▨

" " " " between 1 and 4 A.M. for each week, thus...... ■

Averages in 1909 shown in Red.

each week during the years 1909 and 1910. The amount of rainfall and the average temperature for each week, as observed at the Chestnut Hill Reservoir, are also shown. It will be noted that an increase or decrease in the daily consumption from week to week is coincident with an almost equal reduction in the rate of use between midnight and 4 A.M., indicating that the increase or decrease is due to a waste of water which was continuous throughout the twenty-four hours, and not due to a reduction in use during the hours when the greatest use should take place. Although the consumption, as shown by the diagram, varied from 102,000,000 to 136,000,000 gallons per day during several weeks of the two years, the difference between the night rate and the average daily rate for the corresponding week is shown to have been between 40,000,000 and 45,000,000 gallons, indicating that the changes in consumption are due to changes in the amount wasted rather than in the amount used. In the city of Boston a reduction of 23 gallons per capita has been made in two years, but the fact that in some districts of the city the rate of consumption still remains very high is proof that the further introduction of meters and a careful inspection for leaks in street mains will undoubtedly result in a considerable further lowering of the per capita rate.

The use in the several districts into which Boston is subdivided for purposes of measurement was, in 1908 and 1910, as follows: —

	Population, 1910.	Daily Average Consumption (Gallons).		Gallons per Capita.	
		1908.	1910.	1908.	1910.
Southern low-service includes business, residential and manufacturing districts in city proper, South Boston, Roxbury and Dorchester, ...	350,110	51,313,600	44,667,600	148	128
Southern high-service includes business and residential districts in city proper and residential districts in Roxbury, Dorchester and West Roxbury, . .	211,100	30,112,400	27,077,600	158	128
Charlestown includes greater portion of Charlestown, ...	40,320	7,749,100	7,552,700	195	187
East Boston includes all of East Boston except Breed's Island, ...	56,230	7,278,300	6,172,600	140	110
Brighton high-service, residential district,	11,100	1,299,100	1,192,200	135	107
West Roxbury high-service, residential district, ...	5,010	599,600	655,500	131	131
Breed's Island, residential district, . .	530	27,200	28,500	60	54
	674,400	98,379,300	87,346,700	153	130

Estimated population in 1908, 643,810.

Metering of Service Pipes.

On December 31, 1910, the cities of Boston and Quincy and the town of Revere were the only municipalities which had not complied with chapter 524 of the Acts of 1907 relative to the metering of service pipes. This Act provides that on and after January 1, 1908, all cities and towns which derive their water from the Metropolitan Works shall equip all new service pipes with water meters, and shall also annually equip with meters 5 per cent. of the services which were unmetered on December 31, 1907. More than the required number were set in Boston during the past year, but there is still a deficiency in the total number from previous years.

The number of meters set in these municipalities during the past three years, compared with the number required by law, is as follows: —

	NUMBER OF METERS REQUIRED BY LAW.			NUMBER OF METERS SET.		
	On Old Services.	On New Services.	Total.	On Old Services.	On New Services.	Total.
Boston, ...	13,314	3,462	16,776	11,068	2,313	13,381
Quincy, ...	690	1,170	1,860	814	315	1,129
Revere, ...	414	527	941	379	348	727

The following table gives the statistics relative to the setting of meters and the number of service pipes and meters connected with the distributing pipes in the District on December 31, 1910: —

City or Town.	Number of Meters required to be set on Old Services Each Year.	Meters set on Old Services.			New Services installed, 1910.[1]	New Services equipped with Meters, 1910.[1]	Services in Use December 31, 1910.	Meters in use December 31, 1910.	Per Cent. of Services metered December 31, 1910.
		1908.	1909.	1910.					
Boston, ...	4,438	84	5,503	5,481	1,134	1,134	93,780	18,720	19.96
Somerville, . . .	411	732	621	501	149	227	12,149	5,810	47.82
Malden, ...	14	43	62	8	161	177	7,440	7,163	96.28
Chelsea, ...	240	198	756	779	105	105	4,790	3,082	64.34
Everett, ...	252	338	255	277	62	77	5,380	1,186	22.04
Quincy, ...	230	358	33	423	493	179	7,307	2,634	36.05
Medford, ...	179	857	927	1,555	149	149	4,550	4,296	94.42
Melrose, ...	119	2,432	135	7	79	263	3,583	3,777	100.00
Revere, ...	138	85	184	110	188	185	3,402	885	26.01
Watertown, . . .	-	-	-	-	69	97	2,042	2,070	100.00
Arlington, . . .	55	108	56	63	83	104	2,050	1,288	62.83
Milton, ...	-	-	-	-	74	74	1,454	1,454	100.00
Winthrop, . . .	100	213	975	706	167	167	2,487	2,386	95.94
Stoneham, . . .	65	116	225	186	21	21	1,467	635	43.29
Belmont, ...	-	-	-	-	63	63	909	909	100.00
Lexington, . . .	32	113	70	56	57	57	836	475	56.82
Nahant, ...	16	30	40	26	20	22	532	227	42.67
Swampscott, . . .	21	264	142	28	82	82	1,478	1,465	99.12
Totals, ...	6,310	5,971	9,984	10,206	3,156	3,183	155,636	58,462	37.56

[1] The number of new meters installed and the number of new services equipped with meters seldom agree exactly for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

This table was first prepared for the annual report in accordance with the original returns received from the various municipalities. Revised returns received have caused some changes to be made, particularly in the figures applicable to the city of Boston.

At the end of the year 37.56 per cent. of all the service pipes in the District were metered, as compared with 28.35 per cent. at the beginning of the year. During the past year meters have been placed on a large number of the services in Medford and Winthrop, and at the end of the year there were 8 municipalities in which 94 to 100 per cent. of the services were metered.

Quality of the Water.

The water in the Wachusett and Sudbury reservoirs and Framingham Reservoir No. 3, from which the entire supply of the Metropolitan District was drawn, has been almost entirely free from organisms causing objectionable tastes and odors. The examinations made by the State Board of Health, as well as those made in the laboratory of the Board, have shown that the water delivered in the District has had a lower color and less residue than in any previous year, and that in all respects its quality has compared very favorably with that supplied during previous years.

The growth of Asterionella, which gave the water an objectionable taste and odor for several months in 1909, was not present in sufficient quantity to be objectionable. There was a small growth of Uroglena in the water of Sudbury Reservoir, lasting about two weeks in April, which reappeared about the 10th of May and remained in decreasing quantity until the first of June. Chlamydomonas and Dinobryon were present in the Sudbury Reservoir during the latter half of the year, but never in sufficient quantity to cause trouble. Framingham Reservoir No. 3 contained the same organisms as the Sudbury Reservoir, in small numbers.

The weekly, biweekly and monthly collection and examination of samples of water from the several reservoirs, as well as from taps at several points in the Metropolitan District, have been continued as in previous years. There have been made 2,377 microscopical and 961 bacterial examinations.

The water in Framingham Reservoir No. 2 and in the Ashland, Hopkinton and Whitehall reservoirs was free from objectionable organisms throughout the year. The color of the water in these reservoirs varied from .84 to .116 during the early part of the year and from .38 to .48 during the last six months.

A growth of Chlamydomonas in Lake Cochituate has given the water in that reservoir a disagreeable odor during practically the entire year. Its average color was .26.

There have been small growths of Uroglena in all the distributing reservoirs in the Metropolitan District. The largest numbers were observed in Spot Pond in February and May, in Waban Hill Reservoir about the first of February and during the latter part of May and in Bear Hill Reservoir in May. Although faintly disagreeable odors have been noted in the hot water as drawn from the taps, there has been neither noticeable taste nor odor in the cold water, and no complaints have been received from the water takers. The average color of the water delivered from the low-service taps was .18 and from the high-service taps .12.

The following table gives a comparison of the average results of the examinations of water from a tap in Boston for the years 1902 to 1910, inclusive: —

	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.
State Board of Health Examinations.									
Color (Nessler standard),	0.26	0.25	0.23[1]	0.24[1]	0.24[1]	0.22[1]	0.19[1]	0.18[1]	0.14[1]
Total residue,	3.93	3.98	3.93	3.86	3.86	3.83	3.50	3.46	3.05
Loss on ignition,	1.56	1.50	1.59	1.59	1.39	1.40	1.35	1.43	1.24
Free ammonia,	0.0016	0.0013	0.0023	0.0020	0.0018	0.0013	0.0011	0.0011	0.0013
Albuminoid ammonia, total,	0.0139	0.0125	0.0139	0.0145	0.0159	0.0129	0.0115	0.0128	0.0118
Albuminoid ammonia, dissolved,	0.0119	0.0110	0.0121	0.0124	0.0134	0.0109	0.0092	0.0103	0.0102
Albuminoid ammonia, suspended,	0.0020	0.0015	0.0018	0.0021	0.0025	0.0020	0.0024	0.0025	0.0016
Chlorine,	0.29	0.30	0.34	0.35	0.34	0.33	0.33	0.28	0.28
Nitrogen as nitrates,	0.0092	0.0142	0.0110	0.0083	0.0054	0.0068	0.0092	0.0034	0.0030
Nitrogen as nitrites,	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
Oxygen consumed,	0.40	0.39	0.37	0.35	0.36	0.32	0.26	0.25	0.22
Hardness,	1.3	1.5	1.5	1.4	1.3	1.3	1.2	1.3	1.1
Metropolitan Water and Sewerage Board Examinations.									
Color (platinum standard),	.33	.35	.32	.28	.25	.27	.22	.23	.18
Turbidity,	2.3	2.2	2.4	1.9	2.2	2.2	2.4	2.6	2.1
Total organisms,	367	286	303	528	550	427	695	1,959	421
Amorphous matter,	34	36	36	37	42	47	64	97	72
Bacteria,	164	126	176	231	154	176	148	195	213

Note. — Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased, and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

[1] Platinum standard.

In Appendix No. 2, tables 26 to 32, are given the results of chemical examinations made by the State Board of Health of the water supplied to the Metropolitan Water District.

SANITARY INSPECTION.

The inspection of the several watersheds on which the water supply is collected, and of the grounds connected with the several distributing reservoirs, for the purpose of preventing pollution of the supply or injury to the property of the Board, has been continued as in former years, with a force varying in number from 3 to 15 men. In connection with the inspection a sanitary census has been taken of the several watersheds, and the results as tabulated are presented in the following tables: —

Wachusett Watershed — Sanitary Census by Districts, 1910.

DISTRICT.	PREMISES.					Area (Square Miles, including Water Surfaces).	POPULATION.		Permanent Population per Square Mile.	Horses.	Cattle.	Sheep.	Swine.	Poultry.	Dogs.
	Number on which there are Dwellings occupied throughout the year.	Summer cottages.	Number on which there are Stores or Other Buildings but no Dwellings.	Vacant.	Total Number.		Permanent.	Summer.							
French Brook,	49	4	4	1	58	7.30	206	26	28.2	42	219	4	13	1,220	18
Muddy Brook,	31	2	2	1	36	3.41	126	9	37.0	49	241	-	16	1,067	12
Gates Brook,	127	3	15	8	153	3.93	596	10	151.7	96	228	2	51	2,567	35
Malden Brook,	22	3	1	1	27	3.05	121	11	39.7	32	138	-	7	1,042	12
Chaffin Brook,	162	1	6	12	181	10.56	733	5	69.4	111	306	-	140	5,914	59
Asnebumskit Brook,	198	15	28	41	282	12.96	980	382	75.6	185	416	11	169	5,620	67
Muschopauge,	64	6	5	13	88	11.88	305	157	25.7	101	381	-	96	3,138	35
South Wachusett Brook,	61	12	8	4	85	11.33	228	72	20.1	96	434	25	35	1,862	23
Trout Brook,	28	1	2	2	33	7.65	116	8	15.2	28	85	-	13	1,248	11
East Wachusett Brook,	146	27	18	18	209	20.88	604	384	28.9	240	597	20	99	5,015	43
Stillwater River,	121	3	10	9	143	11.87	586	130	49.4	133	536	20	75	4,189	34
Waushacum,	130	218	20	8	376	7.70	571	815	74.2	131	429	-	87	2,779	35
French Hill,	28	-	1	1	30	5.67	110	-	19.4	20	51	-	1	412	9
Totals,	1,167	295	120	119	1,701	118.19	5,282	2,004	44.7	1,264	4,061	82	802	36,073	393

Sudbury and Cochituate Watersheds — Sanitary Census by Districts, 1910.

DISTRICT.	PREMISES.					POPULATION.		Area (Square Miles, including Water Surfaces).	Population per Square Mile in Dwellings not connected with Sewer.	WATER SUPPLY.			Horses.	Cattle.	Sheep.	Swine.	Poultry.	Dogs.
	Number on which there are Dwellings.	Number on which there are Stores or Other Buildings but no Dwellings.	Vacant.	Total Number.	Connected with Sewer.	Total.	In Dwellings not connected with Sewer.			Premises having Public Water Supply.	Premises supplied by Private Wells, Cisterns, etc.	Premises on which there is no Water Supply.						
Sudbury Watershed.																		
Farm Pond,	238	31	5	274	254	1,568	182	0.54	337.0	263	-	11	84	2	-	-	749	49
Framingham Reservoir No. 3,	82	2	3	87	-	363	363	5.35	67.9	-	84	3	95	309	36	48	3,005	41
Stony Brook,	250	21	24	295	-	1,302	1,302	13.29	98.0	-	271	24	275	898	16	205	6,476	127
Angle Brook,	1,808	116	52	1,976	1,522	11,016	2,255	9.16	246.2	1,814	96	66	509	366	1	590	12,159	509
Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook,	280	6	22	308	-	1,263	1,263	11.72	107.8	44	238	26	167	458	35	191	8,601	127
Eastern Sudbury,	190	18	12	220	-	884	884	3.11	284.2	-	208	12	58	72	4	22	2,832	72
Indian Brook,	356	26	32	414	-	1,402	1,402	7.17	195.5	140	223	51	99	170	-	99	7,245	100
Western Sudbury,	160	16	8	184	-	641	641	7.85	81.7	-	176	8	92	297	27	77	7,062	71
Whitehall Reservoir,	90	8	15	113	-	321	321	7.61	42.2	40	55	18	55	142	1	41	4,591	32
Cedar Swamp,	702	49	47	798	510	3,351	1,143	9.40	121.6	687	50	61	235	487	2	243	9,619	158
Totals,	4,156	293	220	4,669	2,286	22,111	9,756	75.20	129.7	2,988	1,401	280	1,669	3,201	122	1,516	62,339	1,286
Cochituate Watershed.																		
Snake Brook,[1]	307	18	5	330[2]	-	1,609	1,609	4.73	340.2	296	22	12	95	139	-	274	5,631	97
Pegan Brook,	877	71	11	959[2]	656	4,455	1,404	2.24	626.8	926	12	21	268	90	-	17	4,883	226
Course Brook,	81	2	4	87	2	610	350	3.61	97.0	43	38	6	92	349	-	116	3,848	67
Beaver Dam Brook,	1,076	77	28	1,181	866	7,844	1,514	8.15	185.8	1,014	120	47	328	261	-	115	9,989	375
Totals,	2,341	168	48	2,557	1,524	14,518	4,877	18.73	260.4	2,279	192	86	783	839	-	522	24,351	765
Totals for both watersheds,	6,497	461	268	7,226	3,810	36,629	14,633	93.93	155.8	5,267	1,593	366	2,452	4,040	122	2,038	86,690	2,051

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[1] Includes Dudley Pond.

[2] Not including 98 summer cottages and camps on the shores of Lake Cochituate, with a population of 302 on August 1, 1910.

A comparison of these results with those of the Census of 1905 is shown by the following table: —

	WACHUSETT WATERSHED.		SUDBURY WATERSHED.		COCHITUATE WATERSHED.	
	1905.	1910.	1905.	1910.	1905.	1910.
Premises occupied,	1,658	1,582	4,607	4,449	2,873	2,509
Premises vacant,	102	119	303	220	74	48
Premises connected with sewer,	-	-	1,898	2,286	1,427	1,524
Permanent population,	5,772	5,282	21,131	22,111	15,508	14,518
Permanent population per square mile in dwellings not connected with sewers,	49	44.7	140.6	129.7	328.7	260.4
Unsatisfactory cases,	195	61	228	65	133	39

On the Wachusett watershed there has been a reduction of 9 per cent. in the population, and the number of unsatisfactory cases has been reduced from 195 to 61. Since 1905 several buildings on property purchased by the Board for the protection of the water supply, including the Dorr and Warfield mills and tenement houses connected therewith, have been torn down. All the large mills in Holden are now either idle or operating with a reduced number of employés. The decrease in population due to these conditions has been partially offset by the construction of 103 new houses, largely in the towns of West Boylston and Holden, which lie nearest Worcester, and to which better transportation facilities have recently been furnished.

On the Sudbury watershed there has been a reduction in the number of persons residing in houses not connected with sewers which discharge outside the watershed, and the unsatisfactory cases have been reduced from 228 to 65.

The drainage from the Dug Pond watershed, on which there was a resident population of 2,547, was diverted from the Cochituate watershed into Charles River in 1909 and although the remainder of the watershed gained 1,557 in population during the five years, there has been a decrease of 6 per cent. in the resident population on the Cochituate watershed, and the number of unsatisfactory premises has been reduced from 133 to 39.

Under the heading " unsatisfactory " are included all cases where it is possible that under the most unfavorable conditions drainage from privies or sinks may reach a water course, all suspected cases and all cases of manufacturing wastes entering feeders, even though there may have been some attempt at previous purification.

On the Sudbury watershed 14 old and 18 new premises were, during the past year, connected with the public sewers which convey the drainage outside the watershed. Seven of these are in Marlborough, 10 in Westborough and 15 in Framingham. On the Cochituate watershed 13 old and 49 new premises were connected. Fifty of these are in Framingham and 12 in Natick. In the city and towns on the Sudbury and Cochituate watersheds which have systems of sewerage conveying the sewage outside the watershed, there were, on December 31, 1910, 3,810 premises connected with the sewers and 150 premises not yet connected on streets where there are existing sewers, as follows: —

	Premises connected with Sewers.	Premises not connected with Sewers.
Marlborough,	1,522	83
Westborough,	510	25
Framingham,	1,116	9
Natick,	656	33
Sherborn,	6	-
	3,810	150

In Marlborough the regrading of some of the streets has changed the watershed line so that several houses which have been included in previous years are now outside the watershed. This has reduced the number of connections as given in the tables of former years.

Two watchmen were employed to patrol the grounds at Lake Cochituate, one from April 18 to October 1, with special reference to the protection of the supply during the bathing and camping season, and the other from July 16 to December 10, during the camping season and while the Italian laborers employed in constructing a drainage system were engaged in the vicinity of the lake.

The Boston & Worcester Street Railway Company employed a large gang of men for several months in grading the south side of the highway between Framingham Centre and the Southborough line. Measures were taken to prevent the pollution of the watershed on account of this work.

Two boys were summoned into court for bathing in Spot Pond on July 10. They were placed on probation.

On February 24 a resident of West Boylston was arrested for hunting on the marginal lands of the Wachusett Reservoir, and a fine of $5 was imposed by the court.

The presence of a large number of visitors on the reservoir grounds at Chestnut Hill and Spot Pond during the summer season has made necessary the employment at times of men in patrolling the lands of the Board for the purpose of preventing the pollution of the supply and protecting the property. The extension of a car line from Boston through the Middlesex Fells to Stoneham has caused a very great increase in the number of people visiting the grounds around Spot Pond and the Fells Reservoir.

There were 3 cases of typhoid fever reported upon the Wachusett watershed, 1 of which was in Holden, 1 in Princeton and 1 in Boylston, and there were 2 cases of dysentery in Holden.

On the Sudbury and Cochituate watersheds there were 24 cases of typhoid fever reported from Marlborough, 4 from Westborough, 1 from Ashland, 83 from Wayland, 12 from Framingham and 6 from Natick, a total of 130 cases. Investigations made by our inspectors appear to indicate that the large number of cases which occurred in the village of Cochituate, in Wayland, during July, August and September were due to the use of milk from bottles which had not been properly sterilized.

The 24 cases in Marlborough were distributed throughout the year as follows: —

January,	1	September,	6
February,	2	October,	1
March,	1	November,	2
May,	2		
August,	9		24

The patients in 4 of the cases reported in September had been camping at Boone's Pond, in Hudson, and probably contracted the disease while there. Twenty-one of the premises from which cases were reported are connected with the public sewers. In all cases the premises were visited and precautions taken to prevent the spread of the disease or the pollution of the water supply.

A summary of the work of sanitary inspection for the year 1910 is given in the following tables: —

Summary of Sanitary Inspections on the Wachusett Watershed in 1910.

DISTRICT.	Number of Premises inspected.[1]	CLASSIFICATION OF CASES INSPECTED.													CONDITION AT END OF YEAR.		WATER SUPPLY.		
		Cesspools dug before 1910.	Cesspools dug during 1910.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter beds.			Premises having Public Water Supply.	Premises supplied by Private Wells, Cisterns, etc.	Premises on which no Water is used.
							Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.					Satisfactory.	Unsatisfactory.			
French Brook,	58	26	1	-	-	-	27	2	27	1	-	1	2	-	55	3	8	48	2
Muddy Brook,	36	12	1	-	-	-	21	-	22	-	-	1	-	1	36	-	-	36	-
Gates Brook,	153	98	5	-	1	-	41	-	50	-	-	8	2	-	152	1	-	143	10
Malden Brook,	27	13	1	-	-	-	12	-	22	-	-	1	1	-	27	-	-	26	1
Chaffin Brook,	181	85	4	-	1	-	72	8	87	-	-	12	3	-	173	8	66	104	11
Asnebumskit Brook,	272[2]	134	3	2	3	8	68	7	89	-	2	41	8	2	255	17	173	82	17
Muschopauge,	88	22	-	-	1	1	51	2	42	1	-	13	1	-	84	4	5	78	5
South Wachusett Brook,	85	32	-	1	1	1	43	3	50	1	-	4	4	-	80	5	-	81	4
Trout Brook,	33	4	-	-	-	-	25	1	26	-	1	2	-	-	31	2	-	32	1
East Wachusett Brook,	209	80	-	2	-	4	103	5	106	3	-	18	3	1	196	13	-	199	10
Stillwater River,	143	54	-	-	-	-	76	2	75	2	-	9	3	1	140	3	-	137	6
Waushacum,	166[3]	62	3	-	-	1	87	3	58	2	-	8	6	81	161	5	-	148	18
French Hill,	30	19	-	-	-	-	9	-	12	-	-	1	1	-	30	-	-	29	1
Totals,	1,481	641	18	5	7	15	635	33	666	10	3	119	34	86	1,420	61	252	1,143	86

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[1] On some premises there are two or more cases.

[2] Not including 10 summer cottages at Asnebumskit Pond.

[3] Not including 210 summer cottages near Waushacum Lakes.

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1910.

DISTRICT.	Number of Premises inspected.[1]	Classification of Cases inspected.														Condition at End of Year.	
		Sewer Connections.	Cesspools dug before 1910.	Cesspools dug during 1910.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.		Barn Drainage.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.		
								Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.					Satisfactory.	Unsatisfactory.
Sudbury Watershed.																	
Farm Pond,	274	254	9	2	-	-	-	-	1	17	-	-	5	7	-	273	1
Framingham Reservoir No. 3,	87	-	40	3	-	1	-	34	3	43	-	-	3	2	-	84	3
Stony Brook,	295	-	209	10	-	-	-	39	3	114	3	-	24	12	1	289	6
Angle Brook,	1,976	1,522	290	7	-	1	2	104	3	227	-	1	52	17	1,782	1,973	3
Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook,	308	-	174	7	-	-	-	95	3	97	-	-	23	6	-	305	3
Eastern Sudbury,	220	-	161	2	-	-	1	31	1	36	-	-	12	11	-	218	2
Indian Brook,	414	-	195	4	-	-	4	147	13	73	2	-	32	14	-	396	18
Western Sudbury,	184	-	83	3	-	1	-	67	10	67	-	1	8	9	-	173	11
Whitehall Reservoir,	113	-	23	4	-	1	-	61	2	37	-	-	15	5	-	111	2
Cedar Swamp,	798	510	170	3	-	1	-	61	16	133	-	-	47	14	-	782	16
Cochituate Watershed.																	
Snake Brook,	330	-	231	8	-	3	1	60	13	69	-	-	5	9	-	316	14
Pegan Brook,	959	656	225	6	-	-	3	49	-	93	-	1	11	10	923	959	-
Course Brook,	87	2	58	2	-	-	-	19	1	43	-	-	4	2	-	86	1
Beaver Dam Brook,	1,181	866	209	10	-	1	2	44	19	165	3	-	28	14	-	1,157	24
Totals,	7,226	3,810	2,077	71	-	9	13	811	88	1,214	8	3	268	132	2,706	7,122	104

[1] On some premises there are two or more cases.

Swamp Ditches and Brooks.

The drainage ditches and swamps on the several watersheds, aggregating 36.36 miles in length, have been cleaned, and the weeds and brush mowed and burned for a width of from 10 to 20 feet on either side of the ditches. The work of replacing decayed wooden bulkheads on the settling basins at the outlets of ditches entering the open channel of the Wachusett Aqueduct was begun in 1909, and has been completed during the past year by the construction of eight concrete bulkheads 8 inches in thickness, fitted with stop-planks to control the elevation of the water. The cost of the work done during the past year was $345.15. A dry rubble retaining wall on the west side of the highway leading from Marlborough to Westborough, at the crossing of the ditch leading from Brigham Pond, collapsed on March 18. It was rebuilt with stone laid in cement, at a cost of $457.19, the work being finished on April 8. The slopes of the drainage ditches in swamps Nos. 54, 55 and 56, in Holden and Princeton, have been repaired for a distance of 1.46 miles, at a cost of $104.03.

On the Sudbury watershed forty new farm bridges have been built over the drainage ditches, at points where the old bridges were decayed, and the ditches were repaired at several points by replacing the board bottom or repaving the slopes for an aggregate distance of 952 feet on the several ditches. The intercepting ditch along the east side of Pegan Meadow, at Lake Cochituate, was cleaned and the slopes mowed.

Observations of the colors of the waters from swamps have been made monthly and the results tabulated as follows: —

SWAMP.	Area of Watershed (Acres).	Area of Swamp (Acres).	Length of Ditches (Feet).	Colors of Waters (Platinum Standard).					
				BEFORE DRAINING.		AFTER DRAINING.			
				Averages for Years 1894, 1895, 1899.	Averages for Years 1900, 1901, 1902.	1907.	1908.	1909.	1910.
Crane, . .	1,856	460	45,250	1.95	-	.77	.72	.64	.65
No. 54, . .	750	72	8,930	-	.90	.53	.41	.33	.36
No. 55, . .	1,625	220	27,661	-	1.27	.80[1]	.44	.36	.38
No. 76, . .	225	26	6,173	-	.44	.27	.24	.20	.21

[1] Nearly one-half of the ditches in Swamp No. 55 were not built until 1907.

PROTECTION OF SUPPLY.

In addition to the work of sanitary inspection and the care of the swamp ditches, the work of protecting the supply has included the maintenance and operation of filter-beds used to purify the surface water from thickly populated districts before it is admitted to the storage reservoirs. The Marlborough Brook filter-beds, with an area of 14 acres, filter the water from about 1.8 square miles of the thickly settled portion of the city of Marlborough before it is admitted to the Sudbury Reservoir. The settling basin in which the brook water is first received was cleaned in May and June. About 1,600 cubic yards of street washings and silt were removed and disposed of in grading the adjacent grounds, at a cost of about 28 cents per yard. The artificial filter-beds were cleaned twice during the year, once in June and again in September. The entire flow of the brook was filtered, with the exception of a small amount which overflowed from one of the beds into the reservoir on February 28 and March 1. Diluted sewage from the overflow of the Marlborough main sewer ran into the filter-bed on Farm Road on 5 days in January, 4 days in February, 11 days in March and 1 day in December, and there was a flow of ground water into the bed at times during the first four months and the last month of the year.

Surface drainage from an area of about one square mile in the thickly settled portion of Natick is collected in a basin and then pumped to filter-beds before entering Lake Cochituate. The pumps were operated on 155 days during the year, which is a less number than in any year since the beds were constructed. The total quantity pumped during the year was 210,806,000 gallons, equivalent to a daily average of 577,550 gallons. Of the total, 165,037,000 gallons were from Pegan Brook and 45,769,000 gallons from the intercepting ditch which collects water from brooks formerly draining into Pegan Brook Meadow. All of the water from Pegan Brook was filtered, but small quantities from the intercepting ditch were discharged into the lake on 5 days in January, 4 days in February and 5 days in March. The total quantity of coal consumed was 140,658 pounds, and 1,499 gallons of water were pumped per pound of coal. The cost of operating the station, cleaning the filter-beds and caring for the grounds was $2,691.58, making the cost per million gallons treated $12.77.

The Sterling filter-beds have been in continuous operation throughout the year. All of the water coming from the brook which passes through the centre of the town of Sterling enters the filters, and has been efficiently cared for.

The Worcester County Training School filter-beds have been in operation continuously throughout the year, caring for all of the sewage of this institution.

The Gates Terrace filter-beds at Sterling Junction were in commission continuously from April 12 to November 12, inclusive.

Forestry.

In connection with the several reservoirs and aqueducts the Board has under its care and control about 10,000 acres of land a large part of which is covered with trees. Around the Wachusett Reservoir 1,341 acres of land have been planted with white pines during the past eight years. A considerable number of white pines have been planted around the Sudbury Reservoir. There are still several hundred acres on which it is proposed to plant pines, but the greater part of the forestal work now consists in the care of the trees which have been planted, the improvement thinning of forested areas and the care and improvement of forest roads. No additional area was planted on the Wachusett watershed during the past year with white pines as there was no suitable stock available, but the margin of the reservoir was replanted, for a distance of 13.6 miles, with arbor vitæ, spaced 3 feet apart in rows 2 feet apart. This work was necessary because a large proportion of the trees first planted had died. Thirty-six thousand one hundred trees were used in doing this work. Continuing work begun in 1909, 1,281 maples and 230 locusts have been transplanted from fields to the sides of 8.8 miles of highway in Clinton, Boylston, West Boylston and Sterling. Eighty-four white pine trees, averaging 6 feet in height, have been set out on a small grass plot opposite the Boston & Maine Station at Oakdale, also 7 white oaks. Eighteen sugar maples and 10 white oaks have been planted on the grounds at the Wachusett Dam. An area of 1.4 acres on Waushacum Street, in Oakdale, has been cleared and prepared for use as a nursery for the propagation of trees, and it now contains about 30,000 white pine seedlings. The necessary care has been given to the Lamson and Flagg nurseries, and they now contain 18,200 two-year old white pine transplant seedlings and 42,800 arbor vitæ seedlings from 12 inches to 24 inches in height. The work of cutting out trees and brush which interfered with the growth of the young pines, and of making improvement thinning in timber stands varying from twenty to fifty years in age, has been continued.

Around the Wachusett Reservoir an improvement thinning on 112 acres of white pines was made at a cost of $495.69, less $114 received for 58 cords of wood; and 53 acres of old timber land was improved without any expense, as the value of the timber, cord wood, fence posts and railroad ties obtained was fully equal to the cost of making the improvement.

The brush and weeds on all forest roads, along all highway roadsides and on the 40-foot marginal fire guard at the Wachusett Reservoir have been cut and burned.

The lands about the Sudbury Reservoir have been improved by planting 2,500 arbor vitæ seedlings along the shore, on land formerly owned by S. A. and H. S. Howe on Parmenter Street, and on land formerly of W. A. Fay near the Framingham-Marlborough Road.

At Lake Cochituate 1,630 white pines have been planted on land made in 1909 by filling two shallow coves, and 50 white pines have been planted on the grounds at the effluent gate-house.

Three hundred pine trees were set out on the Sudbury Aqueduct land near Wellesley Avenue, in Wellesley, 100 alongside the Cochituate Aqueduct on land in Natick purchased of Harry Felch, and about 500 along the line of the Weston Aqueduct.

On the grounds about the Weston Reservoir 880 trees of different kinds have been set out, and at Spot Pond 100 trees and 2 shrubbery beds have been planted.

The work of protecting trees and shrubbery from the ravages of gypsy and brown-tail moths, pine-tree weevils, elm-leaf beetles and other destructive insects has caused the expenditure of $6,010.21, distributed as follows: —

Spot Pond,	$2,645 35
Mystic Lake, pumping station and reservoir,	144 85
Chestnut Hill Reservoir,	648 89
Weston Reservoir and Aqueduct,	1,246 75
Sudbury and Cochituate aqueducts,	300 50
Lake Cochituate,	109 25
Sudbury Reservoir,	128 67
Framingham Reservoir No. 3,	20 00
Wachusett Reservoir and Aqueduct, gypsy and brown-tail moths,	185 31
Wachusett Reservoir, pine-tree weevil,	580 64
	$6,010 21

This sum is about $2,000 less than the amount expended for the same purposes in 1909.

The method of destroying the insects has been the same as that followed in previous years. During the winter months the egg clusters of the gypsy moth were treated with a mixture of fuel oil and creosote, and the webs of the brown-tail moth were cut off and burned. Wherever the gypsy and brown-tail caterpillars or the elm-leaf beetles were present in large numbers during the summer the trees were sprayed with a mixture of arsenate of lead and water.

The large areas of young pine trees at the Wachusett Reservoir were inspected twice during the season, and all shoots found infested with the weevil were cut off and burned.

At Spot Pond the trees on about 14 acres of land were sprayed between May 26 and July 20, using 650 pounds of arsenate of lead, and 600 pounds of tanglefoot were used in banding the trees. At Chestnut Hill Reservoir 600 pounds of tanglefoot and 890 of arsenate of lead were used. At both Spot Pond and Chestnut Hill the elm-leaf beetle was very destructive, and constant watching and great thoroughness in spraying the trees were required to accomplish effective results. The elm trees were sprayed three times during the season.

At the Weston Reservoir 725 pounds of tanglefoot and 375 pounds of arsenate of lead were used, and about 14 acres of trees were sprayed. At this reservoir the cost of the work was largely increased by the fact that nothing whatever was done to suppress the moths by some of the adjacent property owners. The elm-leaf beetle was more prevalent than in previous years.

Along the Sudbury and Cochituate aqueduct lines the moths were found and destroyed in considerable numbers as far west as Wellesley and Natick.

At the Sudbury Reservoir 1,535 nests of the brown-tail moth and 65 egg clusters of the gypsy moth were destroyed, and a large number of pine tree shoots infested with the weevil were cut off and burned.

A few egg clusters of the gypsy moth have been found in the vicinity of the Wachusett Reservoir. The pine-tree weevil infested the young pines as in previous years but in smaller numbers. During July the whole area of 1,341 acres planted with young pines was inspected, and a second inspection was made in August. The proportion of trees infected varied from 1 in 3 on one or two small lots to 1 in 40 over a large proportion of the area.

In consequence of the extreme drought of the past year the number of forest fires has been unusually large, notwithstanding the fact that a fire-patrol service was maintained on Sundays and holidays at the Wachusett Reservoir and Spot Pond during the spring and fall. Twenty-four fires occurred on the property of the Board, causing a loss of about $2,500. The more important of these were two at the Wachusett Reservoir, which destroyed about 16,000 young pine trees, two in Crane Swamp, which burned over about 90 acres of peat swamp covered with trees, and one near the Hopkinton Reservoir on the Sudbury watershed, which destroyed a good growth of chestnut and oak on about 30 acres.

DISTRIBUTING RESERVOIRS.

Weston Reservoir.

The reservoir, with its connected structures and grounds, has received the usual care and is in good order.

Chestnut Hill Reservoir.

The reservoir, gate-chambers and grounds are in good condition. The exterior woodwork of the old effluent gate-house has been given two coats of paint, and the iron floor of effluent gate-house No. 2 has been scraped and painted.

Waban Hill Reservoir.

The reservoir, gate-house and grounds are in good order.

Forbes Hill Reservoir and Standpipe.

The standpipe has been in use the entire year, and the reservoir has been kept full of water for use in case of emergency. The ironwork in the standpipe tower and the woodwork in the reservoir gate-chamber have been painted. The upper floor of the tower should be resurfaced.

Mystic Reservoir.

The roadway around the reservoir has been repaired, and the exterior woodwork and roof of the gate-house have been given two coats of paint. The reservoir has been in continuous use, except from November 10 to 21, when it was shut off on account of a drowning accident.

Mystic Lake and Pumping Station.

The Metropolitan Park Commission has been allowed to take about 1,500 cubic yards of gravel from a gravel pit on the west shore of the lake for use in resurfacing the Mystic Valley Parkway. A piece of land lying between old and new Mystic Streets, and containing 32,450 square feet, has been sold, as it had no value in connection with the water supply. The exterior woodwork of the old Mystic pumping station and the interior of the stable on the pumping station grounds have been painted.

Arlington Standpipe.

The standpipe has been in use the entire year. No repairs have been made during the year, but the standpipe should be repainted during the coming season.

Spot Pond.

The woodwork of the gate-houses has been painted and the interior ironwork given a coat of black varnish. For the convenience of the large number of visitors at the pond, and as an inducement to keep them away from the water, paths have been constructed on the property of the Board as follows: through what is known as the Deer Hill Lot, between Main Street and Dark Hollow Pond, for a distance of 2,850 feet; on the Hammer Neck Lot for a distance of 2,520 feet; and on the east shore of the pond from Woodland Road, passing by the rear of the pumping station, to the boat-house, a distance of about 1,500 feet. It is proposed to continue the construction of these paths during the coming season. The question of the efficient protection of the water stored in this reservoir from pollution is becoming a serious one, on account of the large number of people who now use as a picnic ground the land draining into the pond, and it seems probable that a system of drains will soon be required to divert all surface water from the watershed from the pond.

Pipe Yards.

The buildings at the Chestnut Hill and Glenwood pipe yards are in good condition, those at the Glenwood yard having received two coats of paint in the spring and those at the Chestnut Hill yard in the fall. The interior of the stable at Chestnut Hill was given a coat of hard oil finish.

Pipe Lines.

The length of pipe lines owned and operated by the Metropolitan Water and Sewerage Board was increased by 4.49 miles during the year, making a total on December 31, 1910, of 97.02 miles. The length of mains 4 inches in diameter and larger, connected with the works but owned and operated by the several cities and towns supplied with water, is 1,633.37 miles.

A number of changes in the Metropolitan pipe lines and in the connections between the Metropolitan mains and the pipes of the local distribution systems have been made during the year. The most important work done has been the relaying of 827 feet of 48-inch main on Boylston Street, in Cambridge, between the parkway at Charles River and Eliot Street. The relaying of this pipe, which had been in the ground but fourteen years, was made necessary by its having been injured by electrolysis, so as to be unsafe for further use. The pipes originally laid were 1.4 inches in thickness. The new pipes laid were 1.7 inches in thickness, and all of the joints, with the exception of those on a curve, were made of wood in place of lead, for the purpose of insulating the pipes and preventing injury in the future. This work was commenced on October 16 and completed on November 30, at a cost of $12,221.40.

The construction of Crafts Road, crossing Reservoir Lane in Brookline, has made necessary the lowering of the 48-inch main in Reservoir Lane for a distance of about 275 feet and to a maximum vertical distance of 6 feet. The main was lowered on November 8 without disconnecting the pipes, by the use of screws from which the main was suspended while the deeper trench was being excavated. In order to lower the pipes to the new grade it was necessary to cut into the top of the old Cochituate Aqueduct to a depth of about 1.6 feet. It is not probable that this portion of the aqueduct will ever be used, but to provide for possible use the brickwork was replaced. The cost of the portion of the work of lowering this main done by the Board was $878.08, which is to be paid for by the town of Brookline.

The 20-inch main which is laid under the Mystic River at High Street, between Medford and Arlington, has been lowered so as to permit of the excavation of a deeper river channel by the Metropolitan Park Commission. The main was lowered for a length of 130 feet, at a cost of $820.70. As the towns of Arlington and Lexington were entirely dependent upon this main for their water supply, a connection was made between the local distribution pipes in Arlington and Somerville by laying 591 feet of 8-inch pipe, of which 231 feet were furnished by the city of Somerville. By means of this connection a partial supply can be furnished in cases of emergency. The cost of making this connection was $643.37.

The construction by the city of Boston of a large culvert at a new location, for use in carrying the waters of Stony Brook under Morton Street, near the Austin Farm, in West Roxbury, has made necessary the relocation of the Metropolitan 36-inch main. In order to avoid interference with the water-way through the culvert, the pipe line was reduced to 30 inches in diameter, and raised so that the top of the pipe is now within 2 feet of the surface of the street for a short distance directly over the culvert.

The construction of the subway in Cambridge by the Boston Elevated Railway Company has necessitated the relocation of 48-inch Metropolitan mains at Central and Harvard squares.

The changes at Central Square were described in the report for 1909, but the work was not completed until June 9 of the past year.

The construction of a subway station at Harvard Square has necessitated the relocation of the 48-inch main from a point 100 feet south of the corner of Boylston and Brattle streets to a point in Massachusetts Avenue 117 feet north of Church Street, a distance of about 650 feet. The relocated pipe line is supported on the masonry structure of the subway for a distance of 400 feet, and at each of the points where the pipes leave the masonry support ball and socket joints were used as a safeguard in case of settlement of the pipes in the earth. At Brattle Street, on account of the shallow depth of cover over the subway roof, the 48-inch main was subdivided into three 24-inch mains, which are laid in special troughs constructed in the subway roof and covered with slabs of reinforced concrete, which protect the pipes from the heavy loads of street traffic. The 24-inch lines are each about 120 feet long, with a valve at either end. The concrete piers which support the 48-inch pipe over the subway are 9 feet long, 5 feet wide and from 6 inches to 2.7 feet high, depending upon the depth of the subway roof below the pipes. In order to maintain the flow of water while the subway construction was in progress a temporary 36-inch main was laid for a distance of 298 feet, and used from June 2 until October 16. The cost of all of these changes, both at Central and Harvard squares, was paid by the Boston Elevated Railway Company, and the employés of the Railway Company performed a large part of the work. The necessary pipes, special castings and valves were obtained under the supervision of this department, and all of the work not done by the department employés was very carefully inspected. The cost of the work done and materials furnished by the Board in connection with the changes at both Central and Harvard squares was $16,693.75.

The two 24-inch mains crossing Chelsea Creek, used in supplying the East Boston District, have been covered with gravel, and the embankments riprapped where they were exposed at low water on the Chelsea shore.

A wooden insulation joint was substituted in December for a rubber joint in the 48-inch main on North Harvard Street, in Brighton, near the Charles River.

Forty-five leaks have been repaired on pipe lines maintained by the Board, at a cost of $1,643.77. No serious breaks occurred in the mains during the year, but three cracked pipes were discovered, while pipe lines laid by contractors were being tested, before the mains had been placed in service. The cost of repairing these was $165.77.

Nine leaks occurred at joints in the lines of 36-inch pipe crossing under the Charles and Mystic rivers. In repairing these it was necessary to use a dredging machine and employ a diver. The cost of the repairs was $955.27. The reduction in the leakage by repairing the submerged pipe lines was 270,000 gallons per day.

Twenty-six leaks were due to defective lead joints, of which four occurred under steam railroad tracks, and five were evidently caused by the settlement of the pipes, due to excavations made for other public work.

The steelwork of the bridge which supports the 48-inch main over the Fitchburg Division of the Boston & Maine Railroad at Massachusetts Avenue, in Cambridge, has been cleaned and painted with two coats of red lead and one coat of Smith's Durable Compound. The sheet lead with which the bottom of the bridge girder was covered in 1907, as a protection against the gases discharged from the locomotives, has been replaced with lead 5/64 of an inch in thickness. A piece of asbestos mill board 1/2 inch thick was also secured to the bottom of the girder over each track, as a protection for the sheet lead. A portion of the wooden roof covering the bridge was renewed with spruce lumber and the roof then covered with two-ply paroid roofing paper. The cost of this work was $537.08.

The pipe bridge over the Mystic River in Medford has been thoroughly cleaned and painted; also three bridges carrying pipes over the Pines River in Saugus.

METERING OF WATER TO MUNICIPALITIES.

There were 62 Venturi meters, in sizes varying from 6 inches to 60 inches, connected with the Metropolitan water mains on December 31, 1910, of which 49 were in use in measuring the water supplied to the several municipalities in the Metropolitan District. There were also 5 Hersey disc meters, 1 Hersey torrent, 1 Hersey detector, 1 Crown and 3 Union rotary meters, which were used to measure the water supplied in districts where the flow was too small to be conveniently measured with a Venturi meter. All of these meters have been read and inspected twice each week, and all necessary repairs made by a regular force of two men with an occasional assistant. Reports have been made monthly to the several municipalities supplied with water, giving the quantities used, and special reports have been made from time to time of the increased use due to leakage or other causes.

Two cases in which the Venturi meters have detected large leaks which did not come to the surface of the ground and were not discovered by the local authorities are worthy of mention. In the city of Medford, in August, the meter indicated an increase of 1,000,000 gallons per day, which was, upon investigation, found to be due to a leak in a cement-lined pipe from which the water was escaping into the Mystic River. In another case a 3-inch main in Brighton was found to be broken, causing a leak, the water escaping into a sewer. The amount of leakage in this case was also about 1,000,000 gallons per day.

PRESSURE REGULATORS AND RECORDING GAGES.

There are eight automatic valves connected with the distribution system. Seven of these have been in constant use during the year to regulate the pressure in the mains in Nahant, Swampscott, Winthrop, Revere, Chelsea, East Boston high service and Lexington, and are in good condition.

The recording pressure gages connected with the distribution system have been in constant use and the average maximum and minimum elevations of the water, due to the pressure at nineteen points in different parts of the District, are given in Appendix No. 2, Table No. 42. The gage in Winthrop has been moved from the Water Works office to the Town Hall on Herman Street.

ELECTROLYSIS.

No complete electrical survey of the Metropolitan water mains was made during the past year, but special measurements have been made from time to time, and a careful examination was made of the pipes removed from Boylston Street, in Cambridge as described on page 118. The iron of these pipes, which was originally 1.4 inches in thickness, was found to be so badly decomposed that over considerable areas the material could be easily cut with a knife to a depth of from ½ to ¾ of an inch. In seven lengths of pipe there were pittings one inch in depth. Along the bottom of one pipe there was a continuous pitting in the form of a groove about 3 inches wide, ⅝ of an inch deep and 10½ feet long, and in one pipe four holes were made entirely through the iron while cleaning out the pittings.

Joints of wood, in place of the ordinary lead joints, have been set on all new pipe lines laid during the year, at intervals of about 500 feet, for the purpose of preventing currents of electricity from following the mains.

CLINTON SEWERAGE.

Pumping Station.

The Clinton sewage-disposal works were in daily operation throughout the year. The quantity of sewage pumped to the filter-beds was 829,000 gallons per day, a decrease of 25,000 gallons per day from the preceding year.

Following are statistics relating to the operation of the pumping station: —

Daily average quantity of sewage pumped (gallons),	829,000
Daily average quantity of coal consumed (pounds),	1,509
Gallons pumped per pound of coal,	549
Number of days pumping,	365

Cost of pumping: —	
Labor,	$1,946 04
Fuel,	1,217 32
Repairs and supplies,	382 56
Total for station,	$3,545 92
Cost per million gallons pumped,	$11.721
Cost per million gallons raised 1 foot high,	0.239

There has been installed in the pump well a 2-inch hydraulic agitator for use in stirring up the sediment from the sewage, which collects around the foot valve of the pump. The pump plungers have been refitted, and a complete set of 72 new rubber valves placed in the pump. The woodwork of both the exterior and interior of the pumping station has been painted.

Filter-beds.

The filter-beds were used in rotation throughout the year, except as interrupted by the work of placing carriers on the beds and the building of sludge beds. Each bed has received an average of 61,100 gallons of sewage in thirty minutes about once in two days. All of the beds were used during the winter season.

The sludge collected in the settling basins, amounting to 688 cubic yards, has all been used on grass lands belonging to the Board at the pumping station and the Wachusett Dam and on the North Dike.

The results of the mechanical analyses of the sewage and effluent are given in the following table: —

[Parts per 100,000]

	1906.	1907.	1908.	1909.	Average of Four Years, 1906-09.	1910.		Whole Year, 1910.
						January to June.	July to December.	
Albuminoid ammonia, sewage,	.8558	.8442	.5735	.7425	.754	.6633	.7467	.7050
Albuminoid ammonia, effluent,	.0955	.0744	.0554	.0819	.0768	.0745	.0628	.0686
Per cent. removed,	89	91	90	89	89.7	89	92	90.3
Oxygen consumed, sewage,	9.84	7.87	3.43	7.04	7.045	6.10	7.2150	6.658
Oxygen consumed, effluent,	1.34	1.07	0.765	1.165	1.085	1.098	0.6742	.8863
Per cent. removed,	86	87	78	83	83.5	82	91	86.7
Free ammonia, sewage,	3.5650	3.8342	4.6193	4.6283	4.1617	3.5700	4.203	3.8867
Free ammonia, effluent,	1.2723	1.3176	1.3722	1.2917	1.3134	.9613	.3373	.6493
Per cent. removed,	64	66	70	70	67.5	73	92	83.3
Nitrogen as nitrates, effluent,	.1445	.1664	.1468	.2319	.1724	.3825	1.085	.7338
Iron, effluent,	2.1042	2.2454	1.8100	1.7633	1.9807	.9200	.3590	.6395

A comparison of the column showing the average results for the four years preceding 1910 with the results for the past year indicates that a very material improvement in the condition of the effluent has been accomplished through the construction of the underdrainage system and the placing of distributors on the surface of the beds during the past three years. The free ammonia in the effluent was less than one-half and the iron less than one-third of the average of the previous four years.

The cost of maintaining the filter-beds, exclusive of the cost of placing distributors on the beds and building two new sludge beds, has been as follows: —

Labor,	$3,228 06
Supplies and expenses,	125 36
Total,	$3,353 42
Cost per million gallons treated,	11 24

The increase in the cost of labor is due to the extra labor required to keep the surface of the beds clear of weeds, on account of the construction of the distributors.

There has been constructed a small shed for the storage of wagons, farming implements, tools, etc., at a cost of $139.69.

Daily tests of the sewage and effluent, to determine the amount of dissolved oxygen and iron, have been made by the keeper in charge of the beds.

During the preceding two years extensive additions were made to the effective filtering area, the underdrainage system and surface distributors.

Continuing along the same line of improvements, in the past year there have been built carriers with concrete bottoms and plank sides upon 15 of the remaining 17 beds, thereby equipping 22 of the 24 one-acre beds. The total length of carriers constructed was 2,844 feet. Carriers have not been built on the 2 remaining beds, pending the removal of about 3 feet of undesirable filtering material at present on the top of these beds.

Two beds each 150 feet x 200 feet between centres of embankments, with a filtering prism of gravel and coarse sand 5 feet in depth, and an aggregate area of 1.06 acres, together with the necessary manholes, distributing pipes, gates and underdrains, have been constructed at the southeast corner of the filter-beds near the settling tanks. These beds are designed to have sufficient capacity to receive and care for the sludge from two settling basins at the same time, and are to be used for this purpose in place of two of the regular filter-beds which have been used for several years but which were not of sufficient area and not conveniently located.

Work was begun upon the construction of the concrete carriers on May 9, and they were completed on July 2, at a cost of $2,808.42, or 99 cents per linear foot. Work on the construction of the sludge beds was begun on August 15, and they were completed on November

18, at a total cost of $4,895.61. All of this work was done by day labor. The total amount expended in improving these beds during the past year has been $7,704.03, and the total expended during the past three years, $17,584.87.

ENGINEERING.

The greater portion of the time of the engineering force employed upon matters pertaining to the maintenance and operation of the works has been devoted to the superintendence of the operation of the Venturi meters and of the flow of water from the several reservoirs through the aqueducts; the determination of the quantities of water used in the several municipalities; the tabulation of the records of rainfall as measured at twelve stations on the works, of the elevations of the several storage and distributing reservoirs, and of the pressures in the mains at different points in the Metropolitan District; the making of calculations to determine the yield of the several watersheds, the quantities delivered by the several aqueducts, the quantities pumped at the several pumping stations and the cost of pumping, the testing of coal and oil, and the examination of the pipes to determine the injury from electrolytic action.

Special engineering work done during the year in connection with the maintenance of the works has included the giving of lines and grades and superintending the construction of filter-beds and distributing carriers at the Clinton sewerage filter-beds and of the new drainage system at Lake Cochituate. A survey of Framingham Reservoir No. 3 has been completed, and plans made on a scale of 100 feet to an inch showing the present high-water mark with reference to the lines of the property belonging to the Board; a survey of Framingham Reservoir No. 2, for the purpose of making similar plans, is now in progress; plans upon the same scale have also been completed, showing the existing shore and property lines around Lake Cochituate, and the location of the Sudbury and Cochituate aqueducts with the location of adjoining property lines and the names of present owners.

Appended to this report are tables giving the amount of work done and other information relative to contracts, a series of tables relating to the maintenance of the Metropolitan Water Works, including the rainfall, yield of sources of supply, consumption of water in the different districts, the number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for 1910.

Respectfully submitted,

DEXTER BRACKETT,
Chief Engineer.

BOSTON, January 2, 1911.

REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following is a report of the operations of the Engineering Department of the Metropolitan Sewerage Works for the year ending December 31, 1910.

ORGANIZATION.

The engineering organization during the year has been as follows: —

Division Engineers:

FREDERICK D. SMITH, .	*In charge of maintenance and construction, South Metropolitan System.*
FRANK I. CAPEN, . .	*In charge of maintenance and construction, North Metropolitan System.*
HENRY T. STIFF, . .	*In charge of office and drafting room.*

In addition to the above, there were employed at the end of the year 13 engineering and other assistants.

METROPOLITAN SEWERAGE DISTRICTS.

AREAS AND POPULATIONS.

During the year no changes have been made in the extent of the sewerage districts. The area of the North Metropolitan District remains at 90.50 square miles, and of the South Metropolitan District at 100.87 square miles, — a total, inclusive of water surfaces, of 191.37 square miles. These districts include the whole or parts of 25 cities and towns, as set forth in the following table.

The populations in the table are based on the census of 1910.

Table showing Areas and Estimated Populations within the Metropolitan Sewerage District, as of December 31, 1910.

	City or Town.	Area (Square Miles).		Estimated Population.	
North Metropolitan District.	Arlington,	5.20		11,490	
	Belmont,	4.66		5,720	
	Boston (portions of),	3.45		103,007	
	Cambridge,	6.11		105,920	
	Chelsea,	2.24		33,090	
	Everett,	3.34		34,310	
	Lexington,[1]	5.11		4,140	
	Malden,	5.07		45,260	
	Medford,	8.35		23,720	
	Melrose,	3.73		15,930	
	Revere,	5.86		18,870	
	Somerville,	3.96		78,500	
	Stoneham,	5.50		7,250	
	Wakefield,	7.65		11,580	
	Winchester,	5.95		9,480	
	Winthrop,	1.61		10,480	
	Woburn,	12.71		15,470	
			90.50		534,217
South Metropolitan District.	Boston (portions of),	20.39		183,000	
	Brookline,	6.81		28,410	
	Dedham,[1]	9.40		9,350	
	Hyde Park,	4.57		15,740	
	Milton,	12.59		8,060	
	Newton,	16.88		40,420	
	Quincy,	12.56		33,320	
	Waltham,	13.63		28,220	
	Watertown,	4.04		13,150	
			100.87		359,670
	Totals,		191.37		893,837

[1] Part of town.

METROPOLITAN SEWERS.

SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

During the year no additions by purchase or otherwise have been made within the sewerage districts, so that there are now 101.985 miles of Metropolitan sewers. Of this total, 8.79 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 93.195 miles of Metropolitan sewers and other works having been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the system: —

North Metropolitan System.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1910.	Special Connections.	
				Character or Location of Connection.	Number in Operation.
Boston: —					
Deer Island,	6′ 3″ to 9′,	1.367	4	– –	–
East Boston,	9′ to 1′,	5.467	24	Shoe factory,	1
Charlestown,	6′ 7″×7′ 5″ to 1′,	3.292	14	Navy Yard, Almshouse,	8 1
Winthrop,	9′,	2.864	11	Club House, Fire Dept. Station, Private Building,	1 1 1
Chelsea,	8′ 4″×9′ 2″ to 1′ 10″×2′ 4″,	5.123	10	Bakery, Rendering works, Metropolitan Water Works blow-off, Chelsea Water Works blow-off,	1 1 1 2
Everett,	8′ 2″×8′ 10″ to 4′ 8″×5′ 1″,	2.925	6	Metropolitan Water Works blow-off, Cameron Appliance Co., Shultz-Goodwin Co., Andrews-Wasgatt Co.,	1 1 1 1
Malden,	4′ 6″×4′ 10″ to 1′ 3″,	4.493[1]	28	Metropolitan Water Works blow-off, Private buildings,	1 143
Melrose,	4′ 6″×4′ 10″ to 10″,	6.099[2]	35	Private buildings, Factory, Railroad station,	109 1 1
Cambridge,	5′ 2″×5′ 9″ to 1′ 3″,	7.167	37	Slaughter house, City Hospital,	1 2
Somerville,	6′ 5″×7′ 2″ to 1′ 10″×2′ 3″,	3.471	10	Tannery, Slaughter-houses (3), Car-house, Street railway power house, Stable, Rendering works,	1 1 1 1 1 1
Medford,	4′ 8″×5′ 1″ to 10″,	5.359	21	Armory building, Private buildings, Stable, Police sub-station,	1 8 1 1
Winchester,	2′ 11″×3′ 3″ to 1′ 3″,	6.428	13	Tannery, Private buildings, Gelatine factory, Stable, Railroad station,	4 2 1 1 1
Stoneham,	1′ 3″ to 10″,	0.010	4	– –	–
Woburn,	1′ 10″×2′ 4″ to 1′ 3″,	0.933	3	Glue factory,	1
Arlington,	1′ 6″ to 10″,	3.520[3]	35	Private buildings, Railroad station, Car-house, Post Office,	130 1 3 1
Belmont,[4]	– –	–	3	– –	–
Wakefield,[4]	– –	–	1	– –	–
Revere,	4′ to 3′,	0.048	2	– –	–
		58.566[5]	261		442

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[1] Includes .988 of a mile of sewer purchased from the city of Malden.

[2] Includes .736 of a mile of sewer purchased from the city of Melrose.

[3] Includes 2.631 miles of sewer purchased from the town of Arlington.

[4] The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.

[5] Includes 2.787 miles of Mystic River valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

South Metropolitan System.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1910.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston (Back Bay),	6′ 6″ to 3′ 9″,	1.500[1]	13	Tufts Medical School, Private house, Administration Building, Boston Park Department, Simmons College buildings, Art Museum,	1 1 1 1 2
Boston (Brighton),	5′ 9″×6′ 0″ to 12″,	6.010[2]	12	Abattoir,	3
Boston (Dorchester).	3′×4′ to 2′ 6″×2′ 7″,	2.870[3]	10	Chocolate works, Machine shop, Paper mill, Private buildings,	2 1 1 2
Boston (Roxbury),	6′ 6″×7′, 4′ 0″,	1.430	-	-	-
Boston (West Roxbury).	9′ 3″×10′ 2″ to 12″,	7.600	9	Parental school, Lutheran Evangelical Church, Private buildings,	1 1 4
Brookline,	6′ 6″×7′ 0″ to 8″,	2.540[4]	12	-	-
Dedham,	4′×4′ 1″ to 3′ 9″×3′ 10″,	2.350	5	-	-
Hull,	60″ pipe,	0.750	-	-	-
Hyde Park,	10′ 7″×11′ 7″ to 4′×4′ 1″,	4.527	17	Mattapan Paper Mills, Private buildings,	1 2
Milton,	11′×12′ to 8″,	3.600	18	-	-
Newton,	4′ 2″×4′ 9″ to 1′ 3″,	2.911	6	Private houses,	2
Quincy,	11′ 3″×12′ 6″ to 24″ pipe,	6.580	10	-	-
Waltham,	3′ 6″×4′,	0.001	1	-	-
Watertown,	4′ 2″×4′ 9″ to 12″,	0.750[5]	6	Factories, Stanley Motor Carriage Co.,	2 1
		43.419	119		29

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[1] Includes .355 of a mile of sewer purchased from the city of Boston.

[2] Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also, .026 of a mile of sewer purchased from the town of Watertown.

[3] Includes 1.24 miles of sewer purchased from the city of Boston.

[4] Includes .158 of a mile of pipe sewer built for the use of the town of Brookline.

[5] Includes .025 of a mile of sewer purchased from the town of Watertown.

COST OF CONSTRUCTION.

[To December 31, 1910.]

The cost of the 101.985 miles of Metropolitan sewers enumerated above, including six pumping stations, screen-house, electric lift station, siphons and appertaining structures, may be summarized as follows: —

North Metropolitan System,	$6,521,196 15
South Metropolitan System,	8,792,779 64
	$15,313,975 79

Information relating to areas, populations, local sewer connections and other data for the whole Metropolitan Sewerage District appear in the following table: —

North Metropolitan District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	CONNECTIONS MADE WITH METROPOLITAN SEWERS.	
					Public.	Special.
90.50	534,217	669.07	465,302	87.1	261	442

South Metropolitan District.

100.87	359,670	542.25	230,365	64.0	119	29

Entire Metropolitan District.

191.37	893,887	1,211.32	695,667	77.8	380	471

Of the estimated gross population of 893,887 on December 31, 1910, 695,667 representing 77.8 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,211.32 miles of local sewers owned by the individual municipalities. These sewers are connected with the Metropolitan System by 380 public and 471 special connections. It appears, also, that there has been during the year an increase of 34.75 miles of local sewers connected with the Metropolitan System, and that 21 public and 8 special connections have been added.

PUMPING STATIONS AND PUMPAGE.

The following table shows the average daily volume of sewage lifted at each of the six Metropolitan pumping stations during the year, as compared with the corresponding volumes for the previous year: —

PUMPING STATION.	AVERAGE DAILY PUMPAGE.			
	Jan. 1, 1909, to Dec. 31, 1909.	Jan. 1, 1910, to Dec. 31, 1910.	Increase during the Year.	
	Gallons.	Gallons.	Gallons.	Per Cent.
Deer Island,	60,600,000	59,000,000	1,600,000[1]	2.6[1]
East Boston,	58,600,000	57,000,000	1,600,000[1]	2.7[1]
Charlestown,	32,100,000	34,300,000	2,200,000	6.9
Alewife Brook,	3,358,000	3,585,000	227,000	6.8
Quincy,	4,163,000	4,132,000	31,000[1]	0.7[1]
Ward Street (actual gallons pumped),	22,700,000	22,900,000	200,000	0.9

[1] Decrease.

CONSTRUCTION.

NORTH METROPOLITAN SYSTEM.

DEER ISLAND PUMPING STATION.

The construction provided for in chapter 566 of the Legislative Acts of 1908 for extensions and additions to the Deer Island pumping station has been practically completed during the year. The additions to the pumping plant, including the 100,000,000-gallon pump, four boilers, economizer and piping, are fully installed, and have been operated in the continuous working service of the house since early in April.

During the year, by-pass channels on the main sewer under the screen-house have been completed by day labor. Contracts for new screening machinery for both the by-pass channel and the main sewer were made with the Hyde Windlass Company of Bath, Me., May 16, 1910. This new screening machinery has been placed by the engineers of the Department; on the by-pass channel, the new screens have been in operation since early in October. On the main sewer, the screens and machinery will be ready for operation early in February.

During the year, two new electric generators, furnished by B. F. Sturtevant Company of Hyde Park, of 17½ kilowatt capacity each, have been placed in the new engine room; new wiring and new electrical fixings and fixtures have been introduced in the new and old engine rooms, the boiler room, coal house and screen rooms. A machine shop has been fitted up at the end of the coal house with small power engine, lathe, power drills, grinders, work benches, forge and blacksmith's outfit. This work has been placed by the engineers of the Department.

During the year, day-labor forces under the direction of the engineer have placed a masonry floor in the new engine house and a new tiled floor in the new and old engine rooms and screen room. Wooden bulkheads and posts in the old coal house have been replaced during the year by reinforced concrete posts and bulkheads.

Test of Deer Island Engine.

Tests of the 100,000,000-gallon engine at Deer Island, as specified in the contract with the Allis-Chalmers Company, were made November 30 and December 1, 1910. These tests were made under the immediate direction of Frank I. Capen, Division Engineer, and William M. Francis, Mechanical Engineer, for the Metropolitan Sewerage Works, and J. R. Belknap, Mechanical Engineer for the Allis-Chalmers Company.

This engine, pump, piping and four new boilers and appurtenances were furnished by the Allis-Chalmers Company of Milwaukee, Wis., under a contract dated November 3, 1908.

The pump was erected between October, 1909, and February, 1910, and was first operated in February, 1910. By agreement between the Board and the Allis-Chalmers Company it has been operated on the regular service of the station since April, 1910, prior to the official test and acceptance by the Board.

The following tables contain principal dimensions of engine and boilers: —

Principal Dimensions of Engine and Pump.

Diameter H. P. cylinder (inches),	18
Diameter I. P. cylinder (inches),	32
Diameter L. P. cylinder (inches),	46
Stroke of pistons (inches),	30
Diameter of suction (inches),	60
Diameter of discharge (inches),	60
Revolutions per minute,	80 to 104

Principal Dimensions of Boilers.

Steam pressure (pounds),	125
Diameter of shell inside smallest ring (inches),	98
Thickness of plates (inches),	13/16
Diameter of furnace inside (inches),	48
Length of furnace (feet),	13
Length of tubes (feet),	13
Diameter of tubes (inches),	2½
Number of tubes,	130
Length of grate (feet),	6
Width of grate (feet),	4

Contract Requirements.

The contract provides that the engine shall fulfil the following requirements: —

Capacity, 100,000,000 United States gallons per twenty-four hours with lift of 19 feet.

The actual head against which the pump is acting to be measured every fifteen minutes by a mercury or other approved gage at a point near the pump end of the discharge channel. This credits the pump with all friction through the Venturi meter, check valves and discharge channels.

Duty guaranteed, 96,500,000 foot-pounds of work for each 1,000 pounds of commercially dry steam used by the engine and auxiliary pump supplied by the Contractor. Steam containing less than 1½ per cent. of entrained water, as determined by calorimeter measurements, to be considered as commercially dry steam.

The pump to discharge into the varying elevations of the tide.

The duration of the test to be twelve hours, starting at low tide, with a minimum lift of 9 feet, and gradually rising to 19 feet at high tide.

The actual elevations in the suction channel to be measured every fifteen minutes by a gage in the suction manhole. The average of all the varying lifts to be used in determining the duty of the pump.

The quantity of sewage lifted to be determined from meter readings taken once every fifteen minutes during the trial by a manometer on the Venturi meter. The sewage to be screened, and to consist of about two-thirds ordinary domestic sewage and about one-third sea water, introduced into the sewer at convenient points above the station.

The engine to be operated continuously during the twelve hours of the trial, under the conditions before outlined, and supplied with steam of not more than 125 pounds pressure per square inch by gage at the throttle valve.

The trials of the engine to be conducted jointly by the Engineer and a representative of the Contractor.

If the duty determined by the official trials of the engine were found to be less than that guaranteed by the Contractor, the sum of $500 for each 1,000,000 foot-pounds of work unperformed below the guaranteed duty, and pro rata for fractional parts, would be deducted from the price bid by the Contractor. If the duty shown by the official trials of the engine were 10 per cent. less than that guaranteed in the contract, the Board might reject the engine.

The type and design of the boilers were specified in the contract, so that no formal boiler tests were required.

Trial.

To furnish the 100,000,000 gallons of water required during the test, tide water was allowed to enter the sewer through the tide gates at Malden River. This tide water furnished about one-third of the total quantity required. To regulate the quantity to be pumped to the rate of 100,000,000 gallons per twenty-four hours, the check valve of the No. 1 pump at the station was braced open. No. 1 pump and engine were also braced so that they could not move. By operating the penstock valve on the suction of this pump, water was allowed to flow back from the discharge sewer in sufficient quantity to give the 100,000,000 gallons per twenty-four hours required during the test. The water in the suction sewer was held at approximately elevation 98, and the elevation in the discharge sewer varied with the tide.

Three boilers furnished the steam used during the test. Steam was conveyed to the engine through one of the duplicate lines of 8-inch steam main, and in order that the leakage should be reduced to the minimum, all connections between this duplicate main and auxiliary steam lines were blanked off by plates inserted between flanges of pipes.

The feed water was taken directly from the city main, weighed in barrels on platform scales and fed to the boilers by the feed pump connected with the engine. For this service a temporary 3-inch pipe line was extended to the economizer.

Quarter-hour observations were made of all pressure gages and other apparatus used in connection with the test. The elevation of water in the discharge channel was determined by a mercury gage, and the quantities of sewage pumped were determined by a manometer attached to the Venturi meter. The height of the water in the suction channel was determined by a hook gage. Calorimeter measurements of the moisture in the steam were made hourly during the test.

All observations were made both by representatives of the Metropolitan Water and Sewerage Board and the Allis-Chalmers Company.

Trial Data and Results.

Date of trial,	November 30 and December 1, 1910
Duration of trial,	12 hours

Average Pressures.

Steam at boilers (pounds),	127.70
Steam at throttle (pounds),	126.50
First receiver (pounds),	20.10
Second receiver (inches of mercury),	5.83
Vacuum,	25.20

Head Pumped against.

Average elevation in suction channel,	98.20
Average net head pumped against,	14.74
Average elevation in discharge channel corrected for losses in discharge pipe, Venturi meter, and check valve,	112.94
Minimum head pumped against,	10.88
Maximum head pumped against,	18.20

Revolutions.

Total revolutions during test,	68,797.00
Average revolutions per minute,	95.55

Useful Work performed by Engine.

Total water pumped (United States gallons per twenty-four hours),	100,700,000

Water fed to Boilers.

Total water weighed (pounds),	55,987
Deduct leakage from boilers, pipes, valves and waste from calorimeter,	906
Total steam chargeable to engine,	55,081
Average entrainment of moisture in steam entering engine in excess of 1½ per cent. (0.19 per cent.),	105
Total dry steam used by engine (pounds),	54,976

Duty.

Duty on foot-pounds per 1,000 pounds commercially dry steam corrected for losses,	112,800,000
Duty foot-pounds per 1,000 pounds water fed to boilers,	110,753,300

Horse Power and Efficiency.

Average indicated horse power,	391.92
Average water horse power,	260.96
Efficiency per cent.,	66.60
Water per indicated horse power per hour,	11.69

The duty developed by this engine during its tests of 112,800,000 foot-pounds of work for each 1,000 pounds of commercially dry steam used exceeds the duty of 96,500,000 foot-pounds guaranteed by the engine builders in their contract by 16.9 per cent.

The efficiency of the pump and engine developed in the test, and expressed in a ratio of useful work accomplished to indicated steam horse power developed, was 66.6 per cent. This exceeds by 20 per cent. the efficiency developed by other engines in this station.

The new plant, including engine, pump, boiler and appurtenances, operated satisfactorily during the tests, and has continued to give satisfactory results since that date in the regular service of the station.

Except for minor repairs, during the year of probation specified in the contract, the plant is in condition for formal acceptance.

East Boston Pumping Station.

Chapters 556 and 582 of the Acts of 1908 provided for repairs to the East Boston station, burned in April, 1908, and for new engine, boiler and coal houses and wharf, with an additional engine, boilers, piping and connections.

As outlined in the last report contracts for repairs to the old station and construction for the new buildings were made in 1909. The building contracts were fully completed as early as November 1, 1910. On July 15, 1910, a contract was made with the John T. Scully Foundation and Transportation Company for pile wharf, steel floor and coal runs. The work under this contract was completed on November 30, 1910.

The wharf is about 40 feet wide at the northerly end of the coal house and extends along the rear of the house for its entire length, varying in width from 10 to 20 feet. This contract included the placing of two coal runs with steel framing. The wharf is built with spruce piles and spurshores and oak fender piles. These are framed with a capping of steel channel irons and diagonal braces of angle irons. It is intended that the wharf construction shall be fireproof. To accomplish this, the steel frames and piles are to be surrounded with concrete and the wharf deck to be of reinforced concrete. This concrete work will be done by day labor under the direction of the Engineer. A portion of the wharf deck at the end of the coal house has been placed and some of the piles surrounded by concrete. This work will be completed in the spring. A concrete retaining wall at the easterly end of the coal house, to defend the approach to the wharf, has been placed during the year by day labor.

As stated in last year's report, a contract was made with the Allis-Chalmers Company of Milwaukee for one 100,000,000-gallon centrifugal pump and engine. The parts for this engine arrived about December 1, and are now being erected. The engine may be in condition to operate some time during the month of March.

The foundations for this pump and engine have been constructed by day labor, under the direction of the Engineer, together with the floor of the basement of the new engine room, of concrete reinforced with twisted steel. The main floor of the new engine room was also placed by day labor. It is of framed steel beams surrounded by concrete and covered with a floor of reinforced concrete. The suction channel leading from the pump well to the new engine has been enlarged for a length of 28 feet, and is now equivalent in area to a pipe 60 inches in diameter. This work has been done by day labor.

The boilers mentioned in the last report as contracted for with the

Robb-Mumford Company have arrived, and have been placed on foundations in the new boiler room, and at the date of this report are equipped and connected and will be in condition to use about the first of March.

Two economizers of 144 3-inch tubes each have been furnished and erected in the boiler room by the B. F. Sturtevant Company. The necessary piping and connections between the engine and boilers are to be made at a later date by the Board.

Stable and Locker Building.

A concrete sea wall has been constructed along the rear of the locker building lot at the corner of Addison and Chelsea streets. The foundations for a stable and locker building 28 feet x 65 feet, two stories high, have been built. The building itself is about half completed.

The foundations and building are of reinforced concrete, including floors and roof. The windows and doors are of steel and the roof will be covered with a terra cotta promenade tile. It is believed that the building will be fire-proof. The work is being done by day labor under the direction of the Engineer.

SOUTH METROPOLITAN SYSTEM.

Sewage Lift at Hough's Neck, Quincy.

Chapter 424 of the Acts of 1899, the High-level Sewer Act, provides that the Board shall construct such pumping stations as shall enable the city of Quincy to drain its sewerage systems by gravity into the Metropolitan sewers.

The mayor of Quincy notified the Board of the intention of the city to construct sewers in low areas at Hough's Neck in the vicinity of Island Avenue, the drainage from which will require to be lifted to the High-level Sewer.

Chapter 292 of the Acts of 1910 authorized the Board to expend such sums as may be required, from unexpended balances of appropriations, to construct necessary works to enable the city of Quincy to drain, by gravity, its territory into the High-level Sewer.

The territory for which relief has been requested includes the easterly and southerly ends of Hough's Neck, involving an ultimate area of 170 acres. This district will ultimately be served by about 8 miles of local sewers. At present, about 3 miles of local sewers are to be built, and it may be many years before more territory will need drainage. The drainage from the area to be sewered at once will be very small. The point at which it will naturally be collected is at the Commonwealth's lot on the westerly side of Island Avenue. This lot is about half a mile distant from the Nut Island screen-house. Provision has been made for lifting this small amount of sewage by an automatic electrically-actuated lift, maintained and operated by the engineers at the Nut Island screen-house. The power for this service is furnished by generators at the Nut Island screen-house.

The works include a concrete storage and pump well holding 50,000 gallons; electrical conduits connecting with the Nut Island screen-house two 6-inch centrifugal pumps of 1,500,000 gallons capacity, each per day actuated by electrical motors; a sewage lift building 14 feet square, covering the pump well, of brick with Quincy granite trimmings and red slate roof.

Contracts for carrying out the work have been made as follows: —

John Cashman & Sons Company, receiving basin, foundations and appurtenances, dated August 29, 1910.

B. F. Sturtevant Company, motors and pumping machinery, dated October 21, 1910.

C. A. Dodge Company, station building, dated November 14, 1910.

At the date of this report the Cashman contract is completed, with the exception of some grading and placing of loam. The building is constructed, the pumps are installed and the plant will be ready to operate in the early spring.

MAINTENANCE.

Scope of Work and Force Employed.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 stations and 101.985 miles of Metropolitan sewers, receiving the discharge from 1,211.32 miles of town and city sewers at 380 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force of 148 men includes 88 engineers and other employés at the pumping stations, and 60 men employed on actual sewer maintenance and care of pumping station grounds. In the following two tables the use of the completed systems and other data are shown: —

NORTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage in this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1910.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.[1]	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Deer Island), .	0.70	Separate, . . .	-	-	1,347[2]	1,347[2]	-	-	100.0	-
Winthrop, ...	29.92	Separate, . . .	2,393	4.30	10,290	10,480	1.29	1.61	98.2	80.1
Boston (East Boston), .	30.43	Separate and combined,	4,568	12.50	57,100	59,840	1.08	2.18	95.4	49.5
Chelsea, ...	29.21[3]	Separate and combined,	3,332[4]	9.00	29,990	33,090	1.10	2.24	90.6	49.1
Everett, ...	43.80	Separate and combined,	4,289	6.55	28,095	34,310	1.89	3.34	81.9	56.6
Malden, ...	55.64	Separate, . . .	5,441	6.10	33,190	45,260	2.81	5.07	73.3	55.4
Melrose, ...	35.91	Separate, . . .	2,785	4.60	12,810	15,930	1.75	3.73	80.4	46.9
Boston (Charlestown), .	21.16	Separate and combined,	5,272	7.90	41,650	41,820	0.67	1.27	99.6	52.8
Cambridge, ...	144.03	Separate and combined,	15,299	6.85	104,795	105,920	4.99	6.11	98.9	81.7
Somerville, ...	94.59	Separate and combined,	14,217	5.45	77,480	78,500	3.33	3.96	98.7	84.1
Medford, ...	52.92	Separate, . . .	3,970	5.75	22,825	23,720	2.83	8.35	96.2	33.9
Winchester, ...	24.05	Separate, . . .	1,236	5.40	6,675	9,480	1.17	5.95	70.4	19.7
Woburn, ...	13.95[5]	Separate, . . .	1,065	5.70	6,070	15,470	0.95	12.71	39.2	7.5
Stoneham, ...	11.75	Separate, . . .	744	4.70	3,495	7,250	0.63	5.50	48.2	11.5
Arlington, ...	23.64	Separate, . . .	1,268	6.10	7,735	11,490	1.72	5.20	67.3	33.1
Belmont, ...	13.40	Separate, . . .	568	6.50	4,195[6]	5,720	1.05	4.66	73.3	22.5
Wakefield, ...	11.75	Separate, . . .	560	5.70	3,190	11,580	0.46	7.65	27.5	6.0
Lexington,[7]	-	- -	-	-	-	4,140	-	5.11	-	-
Revere, ...	32.22	Separate, . . .	2,436	5.90	14,370	18,870	1.77	5.86	76.2	30.2
Totals, . . .	669.07	- -	69,443	6.70	465,302	534,217	29.49	90.50	87.1	32.6

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[1] Estimated from assessors' statement of the number of houses in each city or town, on April 1, 1910, and the population from census of 1910.

[2] Estimated by Superintendent James H. Cronin of the Institution on Deer Island.

[3] The districts connecting at Cypress Street, Revere Beach Parkway, Springvale Avenue, Willoughby, Bellingham, Highland, Hawthorn and Spruce streets are now contributing sewage.

[4] Estimated.

[5] Exclusive of Mystic River valley sewer and tanneries.

[6] Including 2 connections with McLean Hospital, having an estimated population of 503.

[7] Lexington not connected.

SOUTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1910.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.[1]	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Back Bay),	24.65	Separate and combined,	1,608	17.00	27,335	27,800	1.24	1.61	98.3	77.0
Boston (Brighton),	55.78	Separate and combined,	2,994	6.20	18,560	27,300	3.17	3.74	68.0	84.8
Brookline,	65.33	Separate and combined,	3,625	7.50	27,190	28,410	3.43	6.81	95.7	50.4
Newton,	110.04	Separate,	5,850	5.90	34,515	40,420	7.10	16.88	85.4	42.1
Watertown,	35.14	Separate,	1,828	5.50	10,055	13,150	1.93	4 04	76.5	47.8
Waltham,	43.14	Separate,	3,439	7.65	26,210	28,220	2.22	13.63	92.9	16.3
Boston (Dorchester),	49.12	Separate and combined,	4,719	7.50	35,390	59,300	2.32	4.89	59.7	47.4
Milton,	9.83	Separate and combined,	459	5.50	2,525	8,060	0.63	12.59	31.3	5.0
Hyde Park,	26.24	Separate,	1,513	7.60[2]	11,500	15,740	1.28	4.57	73.1	28.0
Dedham,	14.54	Separate,	525	5.40	2,835	9,350[3]	0.73	9.40	30.3	7.8
Boston (Roxbury),	–	– –	–	–	–	40,000	–	1.23	–	–
Boston (West Roxbury),	47.83	Separate and combined,	2,751	5.80	16,955[4]	28,600	2.29	8.92	59.3	25.7
Quincy,	60.61	Separate,	3,263	5.30	17,295	33,320	2.80	12.56	51.9	22.3
Totals,	542.25	– –	32,574	7.10	230,365[5]	359,670	29.14	100.87	64.0	28.9

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[1] Estimated from assessors' statement of the number of houses in each city or town, on April 1, 1910, and the population from census of 1910.

[2] Estimated by City Engineer.

[4] Including connection with Institution at Austin Farm, having an estimated population of 1,000.

[3] Part of town not included in Metropolitan Sewerage District.

[5] Corrected from former estimates by census of 1910.

CAPACITY AND RESULTS.

The following tables summarize the pumping records for the year for the Metropolitan sewerage stations: —

NORTH METROPOLITAN SYSTEM.

Deer Island Pumping Station.

At this station are four submerged centrifugal pumps with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.
Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 42,300,000 foot-pounds.
Average quantity raised each day: 59,000,000 gallons.
Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.
Coal used: Georges Creek, Pocahontas and New River, costing from $3.815 to $4.13 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	2,662,200,000	85,900,000	58,100,000	134,700,000	11.92	45,200,000
February,	2,394,900,000	85,500,000	54,700,000	117,200,000	12.70	45,700,000
March,	2,298,600,000	74,100,000	49,600,000	135,100,000	11.12	41,000,000
April,	1,677,200,000	55,900,000	46,500,000	72,900,000	11.24	40,700,000
May,	1,605,700,000	51,800,000	43,300,000	65,000,000	10.83	39,000,000
June,	1,909,800,000	63,700,000	43,800,000	109,600,000	11.77	54,300,000
July,	1,525,000,000	49,200,000	36,600,000	64,500,000	10.09	41,300,000
August,	1,437,800,000	46,400,000	38,800,000	59,700,000	10.09	36,100,000
September,	1,382,900,000	46,100,000	36,000,000	62,200,000	10.03	41,200,000
October,	1,460,400,000	47,100,000	39,100,000	52,100,000	9.97	42,000,000
November,	1,519,000,000	50,600,000	34,300,000	103,800,000	10.90	42,100,000
December,	1,596,000,000	51,500,000	36,000,000	107,400,000	10.16	38,500,000
Total,	21,469,500,000	-	-	-	-	-
Average,	-	59,000,000	43,100,000	90,400,000	10.90	42,300,000

East Boston Pumping Station.

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 45,500,000 foot-pounds.
Average quantity raised each day: 57,000,000 gallons.
Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen, 1 relief screenman and 3 helpers.
Coal used: New River, costing from $3.545 to $4.20 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January, ...	2,600,200,000	83,900,000	56,100,000	132,700,000	15.75	50,200,000
February, . . .	2,338,900,000	83,500,000	52,700,000	115,200,000	15.45	45,600,000
March, ...	2,236,600,000	72,100,000	47,600,000	133,100,000	15.59	49,000,000
April, ...	1,617,200,000	53,900,000	44,500,000	70,900,000	15.23	47,700,000
May, ...	1,543,700,000	49,800,000	41,300,000	63,000,000	15.36	47,800,000
June, ...	1,849,800,000	61,700,000	41,800,000	107,600,000	15.36	43,000,000
July, ...	1,463,000,000	47,200,000	34,600,000	62,500,000	14.78	35,900,000
August, ...	1,375,800,000	44,400,000	36,800,000	57,700,000	14.98	46,300,000
September, . . .	1,322,900,000	44,100,000	34,000,000	60,200,000	15.08	45,800,000
October, ...	1,398,400,000	45,100,000	37,100,000	50,100,000	15.15	45,500,000
November, . . .	1,459,000,000	48,600,000	32,300,000	101,800,000	14.70	48,100,000
December, . . .	1,534,000,000	49,500,000	34,000,000	105,400,000	15.16	41,400,000
Total, . . .	20,739,500,000	-	-	-	-	-
Average, . . .	-	57,000,000	41,100,000	88,400,000	15.22	45,500,000

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impellers or wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: two, 22,000,000 gallons each, with 11-foot lift; one, 60,000,000 gallons, with 8-foot lift.

Average duty for the year: 55,500,000 foot-pounds.

Average quantity raised each day: 34,300,000 gallons.

Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: New River, costing from $3.835 to $3.90 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	1,383,600,000	44,600,000	32,300,000	69,300,000	8.60	60,900,000
February,	1,276,000,000	45,600,000	36,000,000	63,200,000	9.99	56,200,000
March,	1,167,600,000	37,700,000	26,100,000	69,400,000	10.79	55,100,000
April,	1,041,000,000	34,700,000	27,200,000	47,600,000	10.63	57,800,000
May,	978,200,000	31,600,000	25,200,000	41,700,000	9.49	62,300,000
June,	1,130,600,000	37,700,000	29,000,000	53,200,000	8.49	55,700,000
July,	963,100,000	31,100,000	25,100,000	39,500,000	8.25	53,700,000
August,	858,700,000	27,700,000	22,900,000	35,800,000	8.16	50,100,000
September,	879,100,000	29,300,000	23,800,000	39,100,000	8.20	53,500,000
October,	853,900,000	27,500,000	22,400,000	31,500,000	8.12	53,100,000
November,	929,900,000	31,000,000	22,400,000	56,100,000	8.30	53,500,000
December,	1,008,600,000	32,500,000	23,200,000	55,000,000	8.34	54,300,000
Total,	12,470,300,000	-	-	-	-	-
Average,	-	34,300,000	26,300,000	50,100,000	8.95	55,500,000

Alewife Brook Pumping Station.

The plant at this station consists of the original installation of small commercial pumps and engines, *i.e.,* two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines, together with the recent additions. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.

Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.

Average duty for the year: 18,600,000 foot-pounds.

Average quantity raised each day: 3,585,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 2 screenmen, and 1 relief screenman.

Coal used: New River, Pocahontas and Elk Garden, costing from $4.23 to $4.73 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	**198,550,000**	**6,437,000**	**4,201,000**	**9,453,000**	**12.68**	**27,000,000**
February,	**200,420,000**	**7,158,000**	**5,300,000**	**8,701,000**	**12.84**	**29,200,000**
March,	**196,397,000**	**6,335,000**	**3,380,000**	**9,055,000**	**12.81**	**26,100,000**
April,	**108,037,000**	**3,601,000**	**2,928,000**	**5,170,000**	**12.70**	**18,600,000**
May,	**92,462,000**	**2,963,000**	**2,246,000**	**4,260,000**	**12.79**	**16,900,000**
June,	**100,849,000**	**3,362,000**	**2,162,000**	**5,753,000**	**12.75**	**18,300,000**
July,	**74,214,000**	**2,394,000**	**2,036,000**	**3,079,000**	**12.89**	**15,600,000**
August,	**61,511,000**	**1,984,000**	**1,742,000**	**2,786,000**	**12.89**	**14,400,000**
September,	**62,496,000**	**2,083,000**	**1,700,000**	**3,380,000**	**12.88**	**14,200,000**
October,	**60,063,000**	**1,938,000**	**1,580,000**	**2,550,000**	**12.92**	**13,700,000**
November,	**70,079,000**	**2,336,000**	**1,952,000**	**4,677,000**	**12.94**	**14,300,000**
December,	**75,343,000**	**2,430,000**	**1,868,000**	**5,300,000**	**12.96**	**14,300,000**
Total,	**1,300,421,000**	-	-	-	-	-
Average,	-	**3,585,000**	**2,591,000**	**5,347,000**	**12.84**	**18,600,000**

SOUTH METROPOLITAN SYSTEM.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of pumps: 50,000,000 gallons each, with 45-foot lift.
Average duty for the year: 82,500,000 foot-pounds.
Average quantity raised each day: 22,900,000 gallons.
Force employed: 4 engineers, 4 firemen, 4 oilers, 4 assistant engineers, 1 machinist and 1 laborer.
Coal used: New River, costing from $4.095 to $4.30 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	982,800,000	31,700,000	13,700,000	60,900,000	40.73	98,400,000
February,	887,200,000	31,700,000	24,300,000	44,400,000	41.11	101,000,000
March,	959,000,000	30,900,000	24,100,000	45,200,000	41.23	97,000,000
April,	697,900,000	23,300,000	20,100,000	28,000,000	40.21	81,300,000
May,	659,500,000	21,300,000	17,500,000	27,100,000	40.11	82,700,000
June,	727,000,000	24,200,000	17,500,000	37,100,000	39.94	85,000,000
July,	621,100,000	20,000,000	16,000,000	28,500,000	39.73	82,600,000
August,	534,500,000	17,200,000	14,200,000	21,300,000	39.28	74,500,000
September,	532,100,000	17,700,000	15,200,000	23,300,000	39.49	75,000,000
October,	569,900,000	18,400,000	15,200,000	20,300,000	39.42	69,200,000
November,	596,900,000	19,900,000	16,000,000	39,200,000	39.50	73,400,000
December,	591,600,000	19,100,000	16,300,000	33,600,000	39.52	69,500,000
Total,	8,359,500,000	-	-	-	-	-
Average,	-	22,900,000	17,900,000	34,100,000	40.02	82,500,000

Records from plunger displacement.
Average slip for the year about 10.4 per cent.

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of pumps: 3,000,000 Deane; 5,000,000 Deane; 10,000,000 Lawrence centrifugal.

Average duty for the year: 33,967,000 foot-pounds.

Average quantity raised each day: 4,132,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 2 screenmen and 1 relief screenman.

Coal used: Cumberland, costing from $3.93 to $4.50 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	169,784,000	5,477,000	3,980,000	7,720,000	23.16	33,100,000
February,	160,154,000	5.720,000	4,980,000	6,665,000	23.12	35,500,000
March,	185,923,000	5,998,000	5,015,000	7,290,000	23.35	37,200,000
April,	147,770,000	4,926,000	4,450,000	5,175,000	21.24	40,100,000
May,	139,120,000	4,488,000	4,010,000	5,230,000	21.27	40,100,000
June,	119,680,000	3,989,000	3,620,000	4,620,000	21.29	36,700,000
July,	105,690,000	3,409,000	3,025,000	3,635,000	21.26	33,600,000
August,	96,505,000	3,113,000	2,740,000	3,460,000	21.21	31,700,000
September,	88,485,000	2,950,000	2,740,000	3,235,000	21.22	29,600,000
October,	89,505,000	2,887,000	2,660,000	3,420,000	21.18	29,800,000
November,	97,015,000	3,234,000	2,830,000	3,630,000	21.13	31,200,000
December,	105,325,000	3,398,000	3,025,000	3,940,000	21.20	29,000,000
Total,	1,504,956,000	-	-	-	-	-
Average,	-	4,132,000	3,590,000	4,835,000	21.72	33,967,000

Nut Island Screen House.

The plant at this house includes two sets of screens in duplicate, actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat for the house and burn materials intercepted at the screens.

Average quantity of sewage passing screens daily, 39,600,000 gallons.

Total materials intercepted at screens during the past year, 1,043.3 cubic yards.

Materials intercepted per million gallons of sewage discharged, 1.95 cubic feet.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: New River and Cumberland, costing from $3.98 to $4.05 per gross ton.

COST OF PUMPING.

In the following tables the total cost of pumping and the rate per million foot-gallons at each of six pumping stations are shown in detail: —

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (21,469.5 Million Gallons) × Lift (10.90 Feet) = 234,017.6 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	$12,612 60	$0.05390
Coal,	10,383 31	.04437
Oil,	384 19	.00164
Waste,	190 95	.00082
Water,	1,360 80	.00581
Packing,	308 25	.00130
Miscellaneous supplies and renewals,	2,047 94	.00875
Totals,	$27,283 04	$0.11659[1]
Labor at screens,	-	.01222

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[1] The increased cost of pumping over the record for the preceding year is due to the unusual conditions of operation, occasioned by the installation during the year of a new pumping engine and new sewage screens, necessitating modification of channels and plant; the labor thereon requiring the use of extra materials, increased consumption of coal for hoisting materials and almost continuous operation of the lighting plant, and other incidental expenses of which the amounts cannot be readily estimated.

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (20,739.5 Million Gallons) × Lift (15.22 Feet) = 315,655.2 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	$15,596 57	$0.04941
Coal,	11,198 22	.03547
Oil,	320 51	.00102
Waste,	102 39	.00032
Water,	1,644 00	.00521
Packing,	50 24	.00016
Miscellaneous supplies and renewals,	1,067 59	.00338
Totals,	$29,979 52	$0.09497
Labor at screens,	-	.00698

Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.

Volume (12,470.3 Million Gallons) × Lift (8.95 Feet) = 111,609.2 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	$11,413 18	$0.10226
Coal,	3,910 61	.03504
Oil,	199 35	.00179
Waste,	98 70	.00088
Water,	453 60	.00406
Packing,	40 40	.00036
Miscellaneous supplies and renewals,	642 41	.00576
Totals,	$16,758 25	$0.15015
Labor at screens,	–	.02538

Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.

Volume (1,300.4 Million Gallons) × Lift (12.84 Feet) = 16,697.1 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	$5,695 86	$0.34113
Coal,	1,569 76	.09401
Oil,	149 08	.00893
Waste,	76 50	.00458
Water,	254 20	.01523
Packing,	60 63	.00363
Miscellaneous supplies and renewals,	556 85	.03335
Totals,	$8,362 88	$0.50086
Labor at screens, oiling and miscellaneous services,	–	.11214

Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.

Volume (8,359.5 Million Gallons) × Lift (40.02 Feet) = 334,547 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	$14,136 76	$0.04226
Coal,	7,575 98	.02264
Oil,	304 28	.00091
Waste,	36 08	.00010
Water,	1,390 80	.00416
Packing,	126 68	.00038
Miscellaneous supplies and renewals,	1,645 76	.00492
Totals,	$25,216 34	$0.07537
Labor at screens,	–	.01306

Average Cost per Million Foot-gallons for Pumping at the Quincy Station.

Volume (1,505.0 Million Gallons) × Lift (21.72 Feet) = 32,689 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$4,733 18	$0.14480
Coal,	1,511 02	.04622
Oil,	35 59	.00109
Waste,	15 18	.00048
Water,	225 02	.00688
Packing,	33 11	.00101
Miscellaneous supplies and renewals,	573 21	.01754
Totals,	$7,126 93	$0.21802
Labor at screens, oiling and miscellaneous services,	-	.04772

Coal for use at the several stations has been purchased as follows: —

	Gross Tons, Bituminous Coal.							
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen House.	Contract Price per Gross Ton.[1]
Staples Coal Company,	-	-	672.3	-	-	-	-	$3 64
New England Coal and Coke Company.	-	1,603.79	-	-	-	-	-	3 69
Staples Coal Company,	899.8	-	-	-	-	-	190	3 74
New England Coal and Coke Company.	-	-	318.0	-	-	-	-	3 90
Eastern Coal Company,	-	300.00	-	-	-	-	-	4 00
Staples Coal Company,	639.5	-	-	-	-	-	-	4 04
Staples Coal Company,	-	-	-	-	1,421.32	-	-	4 09
New England Coal and Coke Company.	-	780.11	-	-	-	-	-	4 10
Neponset River Coal Company,	-	-	-	-	-	328.85	-	4 15
Eastern Coal Company,	-	191.56	-	-	-	-	-	4 20
Metropolitan Coal Company,	1,519.0	-	-	-	-	-	200	4 20
New England Coal and Coke Company.	-	-	-	225.41	-	-	-	4 25
Staples Coal Company,	-	-	-	-	399.33	-	-	4 29
Metropolitan Coal Company,	-	-	-	-	130.66	-	-	4 30
Frost Coal Company,	-	-	-	-	-	66.65	-	4 50
New England Coal and Coke Company.	-	-	-	179.74	-	-	-	4 55
Staples Coal Company,	-	-	-	-	74.00	-	-	4 55
Total gross tons,	3,058.3	2,875.46	990.3	405.15	2,025.31	395.50	390	-
Average price per gross ton,	$4 03	$3 87	$3 72	$4 38	$4 16	$4 21	$3 98	-

[1] These prices are given without adjustments for quality.

NORTH METROPOLITAN SYSTEM.

SIPHON UNDER ALEWIFE BROOK.

The pipe siphons under Alewife Brook, fully described in the last annual report, were finished and put in operation on January 26, 1910. Occasional flushing is found necessary to maintain these siphons.

PIPE UNDER CAMBRIDGE SUBWAY.

The siphon on the Cambridge branch of the Metropolitan sewer, under the subway at Portland Street, fully described in the last report, was completed by the Elevated Railway Company on January 11, 1910.

Since that date this siphon has been successfully operated by the maintenance force. It has required flushing and cleaning as often as twice a week.

CHANGES IN LOCATION OF METROPOLITAN SEWER AT CAMBRIDGE SUBWAY, ELIOT SQUARE, CAMBRIDGE.

Under authority of chapter 520, Acts of 1906, the Boston Elevated Railway Company, with the approval of the Board, relocated during the year a length of Metropolitan sewer between stations 33 + 55 and 38 + 25 of section 30 of the Cambridge branch of the North Metropolitan System.

This length is located in Eliot Street and Eliot Square. The Metropolitan sewer in that vicinity is 2 feet 10 inches wide and 3 feet high, of a modified horseshoe section. The relocation is west of the original sewer, in Murray Street and lands of the Elevated Railway Company. For a length of 340 feet in Murray Street the relocated sewer is 2 feet 10 inches wide by 3 feet 6 inches in height, of a modified horseshoe section. From Murray Street to Eliot Street, in private lands for a length of about 320 feet, two lines of cast-iron pipe, 24 inches and 30 inches in diameter, embedded in concrete, are substituted for the masonry sewer. This length passes under the incline approach to the subway. For a length of about 100 feet in Murray Street, and for the whole length in private land, the sewer is built on a pile foundation. The whole length of the detour is 660 linear feet, replacing 470 feet of original Metropolitan sewer.

The abandoned length of Metropolitan sewer in Eliot Square and Eliot Street was bulkheaded and filled with sand.

The introduction of this detour on the line of the Metropolitan sewer avoids siphoning the sewer under the subway.

The work was started by the Railway Company early in July and completed in September.

DRAINAGE FROM TANNERIES, GELATINE AND GLUE WORKS IN WINCHESTER, WOBURN AND STONEHAM.

During the year, 5 men have been employed continuously in cleaning, flushing and brushing the Metropolitan sewers in Winchester, Woburn and Stoneham above Grove Street in West Medford, near the Winchester line.

This is the territory from which large amounts of tannery and other heavy drainage are received into the Metropolitan System. The amount of this drainage is so great that during the year the Board has found it necessary to require the introduction of settling tanks of substantial size on all connections for tanneries, gelatine and glue works, both on Metropolitan and local sewers within this territory.

The ten tanneries in Winchester, Woburn and Stoneham so connected and regulated have a maximum daily capacity of 5,400 hides. About the first of this year these tanneries were handling 2,850 hides.

Gelatine and glue works in Winchester and Stoneham handle nearly 1,500 tons of raw stock.

All of the manufactories excepting two have settling tanks in use at the date of this report. These two are constructing tanks, and will have them in operation as early as the coming spring.

In the accompanying table (No. 1) is outlined the size of tanks, date of introduction and sludge already handled for the portion of the year they have been operated. It appears that about 3,000 cubic yards of semi-liquid sludge have been settled out during the part of the year tanks have been in operation. The table also indicates that when all tanks are in use and all tanneries are operating at full capacity about 8,000 cubic yards of semi-liquid sludge may be intercepted during the year.

Most of these large manufacturers have independent water supplies. The amounts of drainage measured after leaving the settling basins are outlined in the following table (No. 2), which indicates that for considerable periods during the day a continuous sewage flow from the tanneries approximates a rate of 3,000,000 gallons per day, or nearly half the carrying capacity of all the Metropolitan sewers in the territory, and that for smaller periods it considerably exceeds one-half the carrying capacity of the sewers.

No. 1. — *Table of Semi-fluid Sludge removed from Settling Basins at the Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.*

LOCATION OF BASIN.	Basin put in Operation.	Inside Measurement of Basin (Feet).	Number of Times cleaned during Year to Jan. 1, 1911.	Average Quantity Semi-fluid Sludge removed (Cubic Yards).	Total Quantity Semi-fluid Sludge removed to Jan. 1, 1911 (Cubic Yards).	Estimated Quantity Semi-fluid Sludge to be removed Yearly (Cubic Yards).
Beggs & Cobb, Basin No. 1,	**Jan. 15, 1910**	**47.0 × 23.0**	**15**	**92**	**1,380**	**1,500**
Beggs & Cobb, Basin No. 2,	**May 9, 1910**	**47.0 × 23.0**	**2**	**93**	**186**	**500**
American Hide and Leather Company, Factory E.	**Aug. 1, 1910**	**48.3 × 23.0**	**1**	**70**	**70**	**300**
American Hide and Leather Company, Factory D.	**Nov. 15, 1910**	**48.0 × 23.1**	**None**	**-**	**-**	**300**
Cottle Leather Company,	**July 15, 1910**	**49.0 × 28.2**	**5**	**72**	**360**	**800**
B. F. Kimball & Co.,	**Dec. 10, 1910**	**47.2 × 23.0**	**None**	**-**	**-**	**500**
E. Cummings Leather Company.	**Nov. 1, 1910**	**45.9 × 22.6**	**1**	**34**	**34**	**300**
W. P. Fox & Sons,	**July 12, 1910**	**47.8 × 22.6**	**4**	**60**	**240**	**700**
T. F. Boyle & Co.,	**Sept. 15, 1910**	**48.1 × 23.1**	**1**	**92**	**92**	**500**
Champion Tanning Company,	**Not completed**	**46.8 × 22.9**	**None**	**-**	**-**	**200**
Stoneham Tanning Company,	**Not completed**	**-**	**-**	**-**	**-**	**1,200**
American Glue Company,	**Oct. 1, 1910**	**47.1 × 23.0**	**1**	**90**	**90**	**400**
Winchester Manufacturing Company.	**1902**	**35.5 × 24.7 67.2 × 12.0**	**7**	**64**	**448**	**600**
Total,	**-**	**-**	**-**	**-**	**2,900**	**7,800**

No. 2. — *Weir Measurements of Manufacturing Drainage entering the Metropolitan Sewer from Settling Basins at Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.*

NAME.	Weir Measurements (Gallons per 24 Hours).		Maximum Rate of Flow (Gallons per 24 Hours). 1910.	Average Rate of Flow for Nine-hour Day Period (8 A.M. to 5 P.M.) (Gallons per 24 Hours). 1910.	Estimated Per Cent. of Present Business to Maximum Capacity.	Estimated Rate of Flow for Nine-hour Day Period of Maximum Business Capacity (Gallons per 24 Hours).
	1909.	1910.				
Beggs & Cobb, Basin No. 1,	213,000	127,000	565,000	266,700	66⅔	400,000
Beggs & Cobb, Basin No. 2,		57,000	465,000	112,400	66⅔	170,000
American Hide and Leather Company, Factory E.	40,000[1]	40,000	87,000	59,000	66⅔	90,000
American Hide and Leather Company, Factory D.	50,000[1]	2,000[1]	150,000[1]	2,000[1]	–[2]	75,000
Cottle Leather Company,	50,000[1]	1,000[1]	150,000[1]	1,000[1]	–[2]	100,000
B. F. Kimball & Co.,	75,000[1]	75,000	292,000	157,100	100	170,000
E. Cummings Leather Company,	52,000[1]	52,000	141,000	100,100	80	125,000
W. P. Fox & Sons,	80,000[1]	66,000	356,000	124,300	57	220,000
T. F. Boyle & Co.,	120,000[1]	116,000	458,000	254,900	100	275,000
Champion Tanning Company,	50,000[1]	38,000	142,000	72,300	22	125,000
Stoneham Tanning Company,	150,000[1]	100,000[1]	500,000[1]	250,000[1]	50	500,000
American Glue Company,	134,000	83,000	259,000	60,000	100	150,000
Winchester Manufacturing Company,	158,000	145,000	691,000	294,000	100	300,000
Total,	1,172,000	902,000	4,256,000	1,753,800	-	2,700,000

[1] Estimated. [2] Not tanning.

SOUTH METROPOLITAN SYSTEM.

South Metropolitan Outfalls.

The 60-inch outfall pipes in the harbor have been in operation six years at the date of this report. These pipes are in normal condition and free from deposit. During the past year the average flow through them has been 39,600,000 gallons of sewage per day, with a maximum rate of 141,000,000 gallons in the month of January, 1910.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan sewerage stations, consisting of rags, paper and other floating matters, has during the year amounted to 2,335 cubic yards. This is equivalent to 2.7 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan sewerage stations has amounted to 2,312 cubic yards, equal to 4.3 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers, siphons and outfall pipes indicate that they are free from deposit.

Respectfully submitted,

WM. M. BROWN,
Chief Engineer of Sewerage Works.

BOSTON, January 2, 1911.

APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE. — The details of contiacts made before

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	302[1]	4,000 tons 60-inch cast-iron water pipes.	1	-	$98,800 00[2]	United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa.
2	305[1]	4,000 tons 60-inch cast-iron water pipes.	1	-	98,800 00[2]	Florence Iron Works, Camden, N. J.
3	306[1]	200 tons special castings, .	2	$14,640 00	9,400 00[3]	Standard Cast Iron Pipe and Foundry Co., Bristol, Pa.
4	310[1]	Laying 8,070 feet of 60-inch water pipes in Boston and Newton, Sect. 8 of the Weston Aqueduct supply mains.	10	37,044 50	34,908 60[3]	Charles J. Jacobs Co., Boston.
5	312	40-million-gallon pumping engine.	4	105,700 00	99,769 00[3]	Holly Mfg. Co., Buffalo, N. Y.
6	313[1]	32 tons 4-inch to 10-inch cast-iron water pipes, 80 tons special castings.	4	5,508 40	4,854 40[3]	United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa.
7	314	Building pressure tunnel about 1,900 feet in length, and laying 500 feet of 80-inch steel pipe and 930 feet of 60-inch pipe in Newton, Sect. 7 of the Weston Aqueduct supply mains.	9	105,201 00	102,150 00[3]	Joseph Hanreddy, Chicago, Ill.
8	315[1]	159 tons 48-inch cast-iron water pipes.	3	4,173 75[3]	4,046 55	Warren Foundry and Machine Co., New York, N. Y.
9	316[1]	Laying 4,720 feet of 16-inch water pipes in Lynn, Sect. 35 of the distribution system.	13	3,968 30	3,953 40[3]	Charles M. Callahan, Boston.
10	317[1]	210 tons 16-inch cast iron water pipes.	4	5,334 00	5,271 00[3]	United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa.
11	318[1]	1,405 tons cast-iron water pipes: 425 tons 48-inch, 860 tons 36-inch, 120 tons 30-inch.	3	35,646 25[4] 35,450 25[5]	35,265 50[3],[4] 34,579 50[3],[5]	United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa.

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[1] Contract completed.

[2] Joint bid for 8,000 tons was made for contracts Nos. 302 and 305.

[3] Contract based upon this bid.

APPENDIX NO. 1.

THE YEAR 1910 — WATER WORKS.

1910 have been given in previous reports.]

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1910.	10. Value of Work done Dec. 31, 1910.	
May 14, 1909	Mar. 14, 1910	- -	$100,931 88	1
May 14, 1909	Sept. 28, 1910	- -	100,549 39	2
May 14, 1909	Apr. 21, 1910	- -	8,757 20	3
Aug. 18, 1909	Aug. 10, 1910	- -	40,525 39	4
Sept. 21, 1909	-	- -	90,000 00	5
Jan. 26, 1910	Aug. 10, 1910	4-inch, 8-inch and 10-inch pipe $26.70; special castings $50 per ton of 2,000 pounds.	4,459 29	6
Apr. 28, 1910	-	Top soil excavation, $0.60 per cu. yd.; top soil surfacing $0.50 per cu. yd.; earth excavation in open trenches, $0.50 per cu. yd.; rock excavation in open trenches, $3.25 per cu. yd.; refilling open trenches and building embankments, $0.50 per cu. yd.; tunnel excavation, $25 per lin. ft.; crushing stone, $0.75 per cu. yd.; concrete masonry in tunnel, $10 per cu. yd.; concrete masonry in open trench, $6 per cu. yd.; brick masonry, $15 per cu. yd.; cement grout in tunnel, $12 per cu. yd.; cement mortar lining for steel pipe, $5.50 per lin. ft.; laying 80-inch steel pipe, $3 per lin. ft.; laying 60-inch cast-iron pipe, $2 per lin. ft.	65,385 41	7
Mar. 14, 1910	Apr. 30, 1910	48-inch pipe $26.25 per ton of 2,000 pounds, . .	4,769 04	8
Apr. 22, 1910	June 30, 1910	Laying 16-inch cast-iron pipe, $0.77 per lin. ft., .	4,518 30	9
Apr. 5, 1910	June 10, 1910	16-inch pipe $25.10 per ton of 2,000 pounds, . .	5,375 50	10
Apr. 5, 1910	Oct. 15, 1910	48-inch, 36-inch, 30-inch and 20-inch pipe $25.10 per ton of 2,000 pounds delivered by rail; 36-inch and 30-inch pipe $24.40 per ton of 2,000 pounds delivered by water.	36,831 30	11

[4] Delivery by rail.

[5] Delivery by water.

CONTRACTS MADE AND PENDING DURING THE

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	319[1]	110 tons special castings, .	3	$5,797 00	$5,390 00[3]	Standard Cast Iron Pipe and Foundry Co., Bristol, Pa.
2	320	2 vertical fire-tube boilers for Chestnut Hill Low Service Pumping Station.	4	10,640 00	10,448 00[3]	Robb-Mumford Boiler Co., Boston.
3	321[1]	48 tons flexible jointed 48-inch pipe.	3	2,640 00	2,400 00[3]	Warren Foundry and Machine Co., New York, N. Y.
4	322[1]	Laying 3,780 feet of 16-inch water pipe in Arlington, Sect. 36 of the distribution system.	14	4,403 00	3,971 50[3]	De Vincenzi and Baruffoldi, Boston, Mass.
5	323[1]	Laying 8,830 feet of 60-inch water pipe in Newton, Sect. 6 of the Weston Aqueduct supply mains.	9	36,055 60[3]	30,862 50	Cavanagh Bros., Boston, Mass.
6	324[1]	14 water valves: 5 36-inch hydraulic lift, 7 24-inch and 2 16-inch screw-lift valves.	3	9,856 00	8,607 00[3]	Coffin Valve Co., Boston.
7	325	27.8 tons 24-inch cast-iron water pipes; 103.4 tons special castings.	4	8,420 12	5,931 16[3]	Standard Cast Iron Pipe and Foundry Co., Bristol, Pa.
8	326[1]	Laying 3,080 feet of 36-inch and 730 feet of 30-inch water pipes in Chelsea.	9	10,560 10	9,751 00[3]	Michael Russo, Boston.
9	327[1]	5 tons 4-inch and 20 tons 36-inch cast-iron water pipes; 61 tons special castings.	4	3,688 50	3,494 50[3]	United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa.
10	328	Hand travelling crane, .	2	3,096 00	2,500 00[3]	Niles - Bement - Pond Co., Boston.
11	329	Fuel economizer, . .	2	1,822 00	1,740 00[3]	B. F. Sturtevant Co., Boston.
12	330	Hydro-electric plant at Wachusett Dam.	7[6]	71,550 00	71,500 00[3]	S. Morgan Smith Co., York, Pa.
13	332	363 feet 80-inch riveted steel pipe.	4	4,270 00	3,650 00[3]	Hodge Boiler Works, East Boston.
14	16-M[1]	650 tons Davis coal: 250 tons for Arlington Pumping Station; 400 tons for Spot Pond Pumping Station.	4	$3.83 and $4.35 per ton.	$3.70[3] and $4.20 per ton.	New England Coal and Coke Co., Boston.
15	17-M[1]	7,500 tons Vulcan coal for Chestnut Hill pumping stations.	10	$3.70 per ton.	$3.59[3] per ton.	Spring Coal Co., Boston.

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[1] Contract completed.

[3] Contract based upon this bid.

YEAR 1910 — WATER WORKS — *Continued.*

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1910.	10. Value of Work done Dec. 31, 1910.	
Apr. 8, 1910	Dec. 15, 1910	Special castings $49 per ton of 2,000 pounds, . .	$5,767 10	1
Apr. 29, 1910	-	Each boiler with vertical seams of inner and outer furnace sheets riveted $5,224.	10,448 00	2
Apr. 4, 1910	June 10, 1910	48-inch flexible jointed pipe 2½ cents per pound, .	2,191 18	3
May 5, 1910	July 28, 1910	Laying 16-inch cast-iron pipe, $0.50 per lin. ft.; rock excavation above regular grade, $3.40 per cu. yd.	3,333 31	4
June 2, 1910	Dec. 3, 1910	Laying 60-inch cast-iron pipe $3.83 per lin. ft.; laying 12-inch and 16-inch cast-iron pipe for blow-offs, $1.25 per lin. ft.; rock excavation above or below regular grade, $8 per cu. yd.; earth excavation below regular grade, $2 per cu. yd.; chambers for air valves $50 each; chambers for blow-off and by-pass valves and for 36-inch valves $60 each; concrete masonry, $7 per cu. yd.	40,777 77	5
May 17, 1910	Dec. 22, 1910	36-inch hydraulic lift valves, $1,272 each; 24-inch screw-lift valves, $273 each; 16-inch screw-lift valves, $168 each.	8,607 00	6
May 18, 1910	-	Straight pipe $25.20 per ton of 2,000 pounds; special castings $49, $51 and $54 per ton of 2,000 pounds.	4,860 00	7
Aug. 10, 1910	Dec. 8, 1910	Laying water pipes: 36-inch $1.80, 30-inch $1.50 per lin. ft.; rock excavation above regular grade $6, below regular grade $8 per cu. yd.; chambers for blow-off, by-pass and air valves $45 each, for 30-inch and 36-inch valves $75 each; spruce piles driven and cut off, $0.18 per lin. ft.; spruce lumber in place for foundation, $40 per M. feet B.M.; concrete masonry, $6 per cu. yd.	13,086 10	8
July 21, 1910	Oct. 15, 1910	4-inch pipe $26.70, 36-inch pipe $24.70 per ton of 2,000 pounds; special castings $47 per ton of 2,000 pounds.	3,932 64	9
Oct. 24, 1910	-	For whole work $2,500, ...	-	10
Oct. 11, 1910	-	For whole work $1,740, ...	-	11
Dec. 3, 1910	-	For whole work $71,500, ...	-	12
Dec. 6, 1910	-	For whole work $3,650, ...	-	13
June 18, 1909	May 25, 1910	- -	2,693 34	14
July 16, 1909	Sept. 29, 1910	- -	28,171 21	15

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* Includes separate and combined bids for hydraulic and electric plant.

CONTRACTS MADE AND PENDING DURING THE

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	AMOUNT OF BID. 5. Lowest.	6. Contractor.
1	19-M	Improvement of Lake Cochituate, Surface Water Drains in Framingham, Natick and Wayland.	7	$31,298 00	$30,981 00[3]	The Henry Spinach Contracting Co., Waterbury, Conn.
2	20-M	950 tons New River or Pocahontas coal; 250 tons for Arlington Pumping Station; 700 tons for Spot Pond Pumping Station.	3	$4.55 and $4.90 per ton.	$4.20[3] and $4.85 per ton.	New England Coal and Coke Co., Boston.
3	21-M	4,000 tons Beaver Run coal for Chestnut Hill Pumping stations.	7	$3.84 per ton.	$3.83[3] per ton.	Gorman-Leonard Coal Co., Worcester, Mass.
4	22-M	Sale and purchase of electrical energy to be developed at Wachusett Dam.	3	-	$5.30[7] per M. kilowatt hours.	Connecticut River Transmission Co., Boston.
5	Special[1] Order.	5 steel cylinders for tunnel shafts.	4	970 00	838 00[3]	Hodge Boiler Works, East Boston.
6	Special[1] Order.	Steel chambers for Venturi meter registers.	2	996 00	700 00[3]	Daniel Russell Boiler Works, Boston.
7	Special[1] Order.	Steelwork for chambers, .	3	870 00	680 00[3]	James Russell Boiler Works, Boston.
8	Special[1] Order.	1 Type D register and chart recorder for Venturi meter.	–[8]	–[8]	–[9]	Builders Iron Foundry, Providence, R. I.
9	Special Order.	Erecting boilers at Chestnut Hill Pumping Station.	2	660 00	600 00[3]	F. Knight & Son, Boston.
10	Special Order.	2 smoke flues at Chestnut Hill Pumping Station.	4	555 00	536 00[3]	B. F. Sturtevant Co., Boston.

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[1] Contract completed.

[3] Contract based upon this bid.

pletea.

YEAR 1910 — WATER WORKS — *Concluded.*

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1910.	10. Value of Work done Dec. 31, 1910.	
June 22, 1910	-	Earth excavation: for open channel, $1.10 per cu. yd., for covered drains, $0.90 per cu. yd.; borrowed earth, $0.30 per cu. yd.; rock excavation, $10 per cu. yd.; concrete masonry, $7 per cu. yd.; furnishing and laying vitrified clay pipe: 24-inch, $1.10 per lin. ft., 18-inch, $1 per lin. ft., 12-inch, $0.50 per lin. ft.; spruce lumber in place, $33 per M. feet B. M.; stone paving, $1.50 per sq. yd.; gravel for slopes of open channel, $1.50 per cu. yd.; manholes $40 each; catch basins $55 each.	$30,674 52	1
July 25, 1910	-	$4.20 per ton of 2,240 pounds delivered on cars at the Arlington Pumping Station; $4.85 per ton of 2,240 pounds delivered in bins at the Spot Pond Pumping Station.	3,587 00	2
Aug. 18, 1910	-	$3.83 per ton of 2,240 pounds delivered on cars at Chestnut Hill Pumping Stations.	5,756 00	3
Sept. 14, 1910	-	Estimated minimum amount of electrical energy available per year, 5,250,000 kilowatt hours, .	-	4
June 30, 1910	Aug. 10, 1910	- -	833 00	5
July 28, 1910	Oct. 29, 1910	Each complete chamber, $175, ...	698 00	6
July 28, 1910	Oct. 27, 1910	Steelwork for chambers: for 36-inch valves, $45 for each complete set; for 36-inch hydraulic valves, $60 for each complete set.	690 00	7
Aug. 11, 1910	Oct. 12, 1910	- -	525 00	8
Dec. -, 1910	-	- -	-	9
Dec. 23, 1910	-	Flue from boiler to economizer, $478; from economizer to chimney, $58. .	-	10
			$628,783 87	

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[7] Highest bid.

[8] Competitive bids were not received.

Contracts made and pending during the Year 1910 — Water Works — *Concluded.*

Summary of Contracts.[1]

	Value of Work done Dec. 31, 1910.
Wachusett Department, 2 contracts,	-
Distribution Department, 22 contracts,	$555,105 80
303 contracts completed from 1896 to 1909, inclusive,	16,075,309 64
	$16,630,415 44
Deduct for work done on 11 Sudbury Reservoir contracts by the City of Boston,	512,000 00
Total of 337 contracts,	$16,118,415 44

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[1] In this summary, contracts charged to maintenance are excluded.

APPENDIX No. 2.

TABLE No. 1. — *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1910.*

PLACE.		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Wachusett Watershed.	Princeton,	5.43	4.64	1.39	3.44	3.28	4.23	1.82	3.45	2.86	1.36	4.23	2.21	38.34
	Jefferson,	6.99	5.58	1.23	3.09	1.89	3.86	1.16	3.98	2.78	1.23	4.21	2.73	38.73
	Sterling,	5.29	5.62	0.81	2.77	1.68	4.83	1.59	3.91	2.66	1.51	4.16	1.98	36.81
	Boylston,	5.72	5.12	0.92	2.76	1.67	4.52	1.53	4.13	3.14	1.49	4.10	2.43	37.53
Sudbury Watershed.	Sudbury Dam,	5.28	4.96	0.89	2.83	1.26	4.11	1.88	2.24	2.16	1.87	3.90	2.39	33.79
	Framingham,	4.98	5.10	0.77	2.72	1.34	4.81	1.76	2.26	2.57	1.88	4.02	2.43	34.64
	Ashland Dam,	5.45	4.95	0.91	2.61	1.16	5.06	2.37	2.86	2.58	1.71	4.04	2.64	36.34
	Cordaville,	5.87	5.20	0.84	2.82	1.40	4.75	2.11	3.11	2.63	1.96	4.57	2.51	37.77
Lake Cochituate,		5.11	5.16	0.77	2.71	1.33	4.51	2.23	1.58	2.50	1.80	4.16	2.61	34.47
Chestnut Hill Reservoir,		6.11	5.69	1.16	3.57	2.03	5.36	1.93	1.18	2.65	1.69	4.77	2.91	39.05
Spot Pond,		4.80	4.84	1.02	2.68	1.32	4.59	1.47	1.19	2.38	1.13	3.71	2.28	31.41
Average of all,		5.55	5.17	0.97	2.91	1.67	4.60	1.80	2.72	2.63	1.60	4.17	2.47	36.26
Average, Wachusett watershed,		5.86	5.24	1.09	3.01	2.13	4.36	1.52	3.87	2.86	1.40	4.17	2.34	37.85
Average, Sudbury watershed,		5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49	35.64

TABLE No. 2. — *Rainfall in Inches at Jefferson, Mass., in 1910.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	0.34	-	-	-	-	-	0.30	-	-	-
2,	-	-	-	-	-	-	-	0.55	-	-	[2]	-
3,	-	[2]	-	-	-	-	-	-	0.65	-	[2]	-
4,	-	0.38[1]	-	-	-	-	-	0.54	-	-	2.20	-
5,	[2]	-	-	-	0.27[3]	[2]	-	-	[2]	-	-	-
6,	[2]	-	-	-	-	0.89	-	-	0.94	-	-	-
7,	1.99[3]	-	0.72	-	-	-	-	-	-	0.20	-	-
8,	-	-	-	-	-	-	-	-	-	-	-	-
9,	-	0.38[3]	-	-	0.36	[2]	-	-	-	0.24	[2]	-
10,	-	-	-	-	-	[2]	-	[2]	-	-	0.24	-
11,	-	[2]	-	0.51	-	1.77	-	1.72	-	-	-	-
12,	-	1.79[3]	-	-	-	0.80	-	-	-	-	0.06[1]	-
13,	-	-	-	-	-	-	0.18	-	-	-	-	-
14,	[2]	-	-	-	0.19	-	0.15	-	-	-	-	-
15,	1.29[1]	-	-	-	-	-	-	0.27	-	0.07	-	0.35[1]
16,	-	-	-	-	-	[2]	-	0.29	-	-	-	-
17,	-	1.28[3]	-	-	-	0.40	-	-	-	-	-	-
18,	0.51[3]	-	-	0.89	0.31	-	-	-	-	-	-	-
19,	-	-	-	-	-	-	-	0.55	-	-	-	0.17
20,	-	-	0.17	-	-	-	-	-	-	-	-	0.04[3]
21,	[2]	0.54	-	-	0.11	-	-	-	0.24	-	-	0.35[1]
22,	1.44	0.73[1]	-	0.14	-	-	-	-	-	0.34	0.14	-
23,	-	0.08[1]	-	-	-	-	-	-	-	-	-	-
24,	-	-	-	-	-	-	-	-	0.17	-	-	1.32
25,	0.74[1]	-	-	1.00	0.27	-	-	-	-	0.13	0.17[3]	-
26,	-	-	-	0.38	-	-	-	0.06	-	-	-	-
27,	0.14[1]	[2]	-	-	-	-	-	-	[2]	0.25	-	-
28,	[2]	0.40	-	-	-	-	0.33	-	0.48	-	[2]	0.14
29,	0.88[3]	-	-	0.17	-	-	-	-	-	-	1.40[1]	0.36
30,	-	-	-	-	-	-	0.50	-	-	-	-	-
31,	-	-	-	-	0.38	-	-	-	-	-	-	-
Totals,	6.99	5.58	1.23	3.09	1.89	3.86	1.16	3.98	2.78	1.23	4.21	2.73

Total for the year 38.73 inches.

[1] Snow. [2] Rainfall included in that of following day. [3] Rain and snow.

TABLE No. 3. — *Rainfall in Inches at Framingham, Mass., in 1910.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	–	–	³	–	³	0.03	–	–	0.45	–	–	–
2,	–	–	0.20	–	0.03	–	–	–	–	–	³	–
3,	0.02¹	³	–	–	³	0.05	–	–	0.45	–	³	–
4,	–	0.47²	–	0.02	³	–	–	0.38	–	–	³	–
5,	³	–	–	–	0.23	³	–	–	0.51	–	2.29	–
6,	³	–	–	–	–	³	–	–	0.72	–	–	³
7,	1.84²	–	0.38	³	–	1.07	–	–	–	0.13	–	0.37¹
8,	–	–	–	0.25	³	–	0.05	–	–	–	–	–
9,	–	0.23²	–	0.02	0.25	³	–	–	–	0.47	³	–
10,	–	–	–	–	0.01	³	–	³	–	–	0.31	–
11,	–	³	–	0.30	–	³	–	1.08	–	–	–	–
12,	–	1.64²	–	–	–	2.45	–	–	–	–	–	–
13,	³	–	0.06²	–	–	–	0.19	–	–	–	–	–
14,	³	–	–	–	–	–	–	–	–	³	–	–
15,	0.93¹	–	–	–	0.02	–	–	³	–	0.20	–	0.08¹
16,	–	³	–	–	–	³	0.23	0.08	–	–	–	–
17,	³	0.92²	0.02¹	³	–	0.78	–	–	–	–	–	–
18,	0.29²	–	–	³	0.31	0.33	–	³	–	–	–	³
19,	–	–	–	³	–	–	–	0.57	³	–	–	0.13
20,	–	–	0.07	0.75	³	–	–	–	0.07	0.11	–	0.40¹
21,	³	0.49	–	³	0.07	–	–	–	0.05	–	–	0.01¹
22,	0.59	0.52²	–	0.44	³	–	–	–	–	³	–	–
23,	–	–	–	–	0.04	–	–	–	–	0.56	–	³
24,	–	–	–	–	–	0.06	–	–	0.11	–	–	1.27
25,	0.48²	–	–	–	0.02	–	0.46	–	–	0.35	0.19	–
26,	³	–	–	0.88	–	–	–	0.13	–	–	–	0.05¹
27,	0.10²	³	–	–	–	³	³	–	³	³	–	–
28,	³	0.83	–	–	0.04	0.04	0.35	³	0.21	0.06	³	0.06²
29,	0.70²	–	–	³	–	–	–	0.02	–	–	³	–
30,	³	–	–	0.06	³	–	0.48	–	–	–	1.23²	0.11
31,	0.03¹	–	0.04	–	0.32	–	–	–	–	–	–	–
Totals,	4.98	5.10	0.77	2.72	1.34	4.81	1.76	2.26	2.57	1.88	4.02	2.43

Total for the year 34.64 inches.

² Snow. ³ Rainfall included in that of the following day. ¹ Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1910.*

DATE.	Amount.	Duration.
Jan. 3, . .	.09[1]	10.15 A.M. to 2.15 P.M.
Jan. 5, . .	2.06[2]	8.00 A.M. to
Jan. 7, . .		1.00 P.M.
Jan. 10, . .	.05[1]	4.20 A.M. to 7.30 A.M.
Jan. 14, . .	1.43[1]	12.45 A.M. to
Jan. 15, . .		1.00 P.M.
Jan. 18, . .	.40[2]	2.15 A.M. to
Jan. 19, . .		1.15 A.M.
Jan. 21, . .	.73	4.15 P.M. to
Jan. 22, . .		5.45 P.M.
Jan. 25, . .	.47[2]	3.10 P.M. to 11.45 P.M.
Jan. 27, . .	.05[2]	12.30 A.M. to 2.55 A.M.
Jan. 28, . .	.80	10.40 P.M. to
Jan. 29, . .		10.30 P.M.
Jan. 30, . .	.03[1]	7.55 P.M. to 10.15 P.M.
Total, .	6.11	
Feb. 3, .	.60	7.00 P.M. to
Feb. 4, .		2.45 A.M.
Feb. 4, .	.25[1]	2.45 A.M. to 3.15 P.M.
Feb. 9, .	.21	7.10 P.M. to 11.20 P.M.
Feb. 11, .	1.52[1]	9.00 P.M. to
Feb. 12, .		9.10 A.M.
Feb. 12, .	.03	9.10 A.M. to 5.30 P.M.
Feb. 17, .	.92[2]	2.05 A.M. to
Feb. 18, .		5.00 A.M.
Feb. 21, .	.58	2.45 A.M. to 11.35 P.M.
Feb. 22, .	.57[2]	9.05 A.M. to 8.30 P.M.
Feb. 27, .	1.01	9.45 P.M. to
Mar. 1, .		8.00 A.M.
Total, .	5.69	
Mar. 1, .	.29	8.00 A.M. to
Mar. 2, .		4.30 P.M.
Mar. 6, .	.65	9.00 P.M. to
Mar. 7, .		10.30 A.M.
Mar. 14, .	.08	12.15 A.M. to 1.55 A.M.
Mar. 20, .	.04	6.15 P.M. to 10.30 P.M.
Mar. 31, .	.10	7.55 P.M. to 10.00 P.M.
Total, .	1.16	
Apr. 4, .	.02	4.30 P.M. to 7.20 P.M.
Apr. 7, .	.49	11.20 P.M. to
Apr. 8, .		9.50 P.M.
Apr. 11, .	.34	6.30 P.M. to
Apr. 12, .		12.10 A.M.
Apr. 17, .	.90	7.30 P.M. to
Apr. 19, .		5.15 A.M.
Apr. 19, .	.05	8.00 P.M. to
Apr. 20, .		5.00 A.M.
Apr. 22, .	.58	2.40 A.M. to 11.30 A.M.
Apr. 26, .	1.11	5.35 A.M. to 10.45 P.M.
Apr. 29, .	.08	11.15 P.M. to
Apr. 30, .		8.00 A.M.
Total, .	3.57	
May 2, .	.03	4.20 A.M. to 4.35 A.M.
May 4, .	.09	4.30 P.M. to
May 5, .		2.30 P.M.
May 8, .	.20	2.30 P.M. to
May 9, .		2.30 P.M.
May 15, .	.05	11.10 A.M. to 12.50 P.M.
May 18, .	.37	11.20 A.M. to 7.20 P.M.
May 21, .	.21	4.45 A.M. to 8.00 P.M.
May 25, .	.08	11.40 A.M. to
May 26, .		12.10 A.M.
May 27, .	.04	11.30 A.M. to
May 28, .		9.00 A.M.
May 28, .	.03	11.40 A.M. to 11.50 P.M.
May 30, .	.88	11.30 A.M. to
May 31, .		11.40 A.M.
May 31, .	.05	7.35 P.M. to 9.30 P.M.
Total, .	2.03	
June 5, .	1.11	10.45 P.M. to
June 7, .		5.15 P.M.
June 9, .	3.40	10.40 P.M. to
June 12, .		10.30 P.M.
June 16, .	.81	10.00 A.M. to
June 17, .		2.10 P.M.
June 28, .	.04	12.40 A.M. to 8.30 A.M.
Total, .	5.36	
July 8, .	.10	6.05 A.M. to 7.15 A.M.
July 13, .	.11	1.15 P.M. to 2.15 P.M.
July 16, .	.43	1.00 P.M. to 11.35 P.M.
July 25, .	.51	5.00 P.M. to 8.45 P.M.
July 28, .	.28	2.35 A.M. to 5.40 A.M.
July 30, .	.29	9.50 A.M. to 11.20 A.M.
July 30, .	.21	4.30 P.M. to 5.30 P.M.
Total, .	1.93	
Aug. 4, .	.13	12.30 P.M. to 8.30 P.M.
Aug. 10, .	.19	6.15 P.M. to
Aug. 11, .		8.00 A.M.
Aug. 11, .	.09	6.45 P.M. to 10.00 P.M.
Aug. 19, .	.53	12.50 A.M. to 9.25 A.M.
Aug. 26, .	.24	10.35 A.M. to 10.45 A.M.
Total, .	1.18	
Sept. 1, .	.69	8.05 A.M. to 7.00 P.M.
Sept. 3, .	.61	3.05 P.M. to 12.00 M.
Sept. 5, .	.41	12.50 A.M. to
Sept. 6, .		12.10 A.M.
Sept. 6, .	.46	6.45 P.M. to 11.20 P.M.
Sept. 21, .	.25	4.50 A.M. to 5.40 A.M.
Sept. 24, .	.04	5.50 P.M. to
Sept. 25, .		12.15 A.M.
Sept. 28, .	.19	12.50 A.M. to 8.15 A.M.
Total, .	2.65	

[1] Snow.

[2] Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1910* — Concluded.

DATE.	Amount.	Duration.
Oct. 7,	.21	10.15 A.M. to 9.00 P.M.
Oct. 9,	.31	5.40 P.M. to 9.20 P.M.
Oct. 15,	.11	4.00 P.M. to 8.35 P.M.
Oct. 20,	.06	9.00 A.M. to 4.30 P.M.
Oct. 22,	.69	2.30 P.M. to 7.50 A.M.
Oct. 23,		
Oct. 25,	.21	6.45 P.M. to 7.45 P.M.
Oct. 27,	.10	6.15 P.M. to 8.15 A.M.
Oct. 28,		
Total,	1.69	
Nov. 2,	.52	7.50 P.M. to 10.45 A.M.
Nov. 3,	2.30	7.15 P.M. to 9.15 P.M.
Nov. 4,		
Nov. 10,	.37	12.25 A.M. to 7.15 A.M.
Nov. 10,	.03	7.00 P.M. to 8.00 P.M.
Nov. 25,	.11	7.15 A.M. to 5.15 P.M.
Nov. 29,	1.44[2]	12.20 A.M. to 4.55 A.M.
Nov. 30,		
Total,	4.77	

DATE.	Amount.	Duration.
Dec. 6,	.56[1]	11.15 A.M. to 8.00 A.M.
Dec. 7,		
Dec. 15,	.13	2.45 P.M. to 12.10 A.M.
Dec. 16,		
Dec. 18,	.22	11.50 P.M. to 10.45 A.M.
Dec. 19,		
Dec. 20,	.22[1]	7.35 P.M. to 3.00 A.M.
Dec. 21,		
Dec. 24,	1.52	6.15 A.M. to 11.40 P.M.
Dec. 26,	.05[1]	4.30 P.M. to 12.35 A.M.
Dec. 27,		
Dec. 28,	.09	4.50 P.M. to 10.00 P.M.
Dec. 29,	.12	3.40 P.M. to 8.00 A.M.
Dec. 30,		
Total,	2.91	

Total for the year 39.05 inches.

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[1] Snow.

[2] Rain and snow.

TABLE No. 5. — *Rainfall in Inches on the Wachusett Watershed,*[1] *1897 to 1910.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897, ...	3.46	2.86	4.01	2.32	5.06	5.11	8.65	3.47	1.93	0.94	7.62	6.41	51,84
1898, ...	6.65	3.30	2.27	4.43	3.38	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899, ...	2.93	5.12	6.75	1.94	1.33	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900, ...	4.56	8.69	6.19	2.76	4.34	3.59	3.20	3.18	3.46	2.90	6.44	3.15	52.46
1901, ...	1.75	1.13	5.82	9.64	7.02	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902, ...	2.72	4.91	5.27	4.36	2.24	2.51	3.87	3.95	4.26	6.36	0.93	7.20	48.58
1903, ...	2.85	4.42	6.58	3.10	1.24	10.37	3.43	3.88	2.93	4.43	2.36	3.99	49.58
1904, ...	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
1905, ...	6.10	1.72	3.95	2.60	0.83	4.88	5.39	3.09	6.90	1.81	2.52	3.79	43.58
1906, ...	2.59	2.74	5.17	3.12	6.58	5.95	5.52	4.34	2.61	3.95	2.25	4.26	49.08
1907, ...	2.84	2.32	1.82	2.65	2.96	3.54	3.03	1.26	9.50	5.68	5.74	4.40	45.74
1908, ...	3.40	4.82	2.77	2.62	5.34	1.29	3.85	6.49	1.04	2.13	1.05	3.03	37.83
1909, ...	3.52	6.10	4.38	5.71	2.65	3.03	4.25	3.50	3.90	1.70	1.68	3.99	44.50
1910, ...	5.86	5.24	1.09	3.01	2.13	4.36	1.52	3.87	2.86	1.40	4.17	2.34	37.85
Totals, ...	53.25	56.03	59.47	55.71	48.09	58.20	59.04	59.19	55.05	46.71	47.56	60.82	659.12
Average (14 years), . .	3.80	4.00	4.25	3.98	3.43	4.16	4.22	4.23	3.93	3.34	3.40	4.34	47.08

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[1] Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1910, Princeton, Jefferson, Sterling and Boylston.

TABLE NO. 6. — *Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1910.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4 21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.52	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.98
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.18	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74

[1] See note at bottom of page 174.

TABLE No. 6.—*Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1910.*—Concluded.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1895, ...	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896, ...	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897, ...	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898, ...	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
1899, ...	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.09	2.18	1.78	37.21
1900, ...	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.36	3.83	5.70	2.74	50.65
1901, ...	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902, ...	2.52	6.18	5.34	4.13	1.86	2.89	2.94	3.40	4.54	4.44	1.45	6.38	46.07
1903, ...	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904, ...	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.78	2.92	42.82
1905, ...	5.26	2.20	3.15	2.72	1.31	5.00	5.47	2.70	6.88	1.54	2.07	4.01	42.31
1906, ...	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48
1907, ...	3.28	2.17	1.91	3.41	3.63	3.53	1.86	1.07	8.76	4.17	6.12	4.47	44.38
1908, ...	3.60	4.56	3.82	1.88	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14	36.15
1909, ...	3.98	5.79	4.26	4.67	2.43	2.81	1.59	2.93	4.74	1.12	3.88	4.05	41.75
1910, ...	5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49	35.64
Totals, ...	150.17	152.84	158.10	126.56	120.15	113.37	128.19	138.57	136.72	141.40	138.07	137.11	1,631.25
Average (36 years), . .	4.17	4.25	4.39	3.51	3.34	3.15	3.56	3.85	3.52	3.93	3.83	3.81	45.31

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[1] Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June, 1898, to December, 1910, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile*[1] *from 1897 to 1910.*

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	Mean for 14 Years, 1897–1910.
January, ...	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000	1,265,000	659,000	1,266,000	1,132,000	1,458,000	1,738,000	592,000	1,846,000	1,243,000
February, . . .	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000	927,000	452,000	1,027,000	692,000	1,736,000	2,556,000	1,845,000	1,487,000
March, ...	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,004,000	1,860,000	1,697,000	2,192,000	2,129,000	2,640,000	2,786,000
April, ...	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000	2,984,000	1,617,000	2,109,000	1,436,000	1,269,000	2,422,000	1,034,000	2,205,000
May, ...	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	445,000	1,533,000	965,000	1,415,000	1,212,000	608,000	1,200,000
June, ...	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000	762,000	542,000	1,184,000	773,000	403,000	632,000	824,000	842,000
July, ...	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	497,000	365,000	728,000	335,000	220,000	233,000	62,000	441,000
August, ...	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000	355,000	321,000	591,000	87,000	443,000	193,000	186,000	437,000
September, . . .	380,000	676,000	250,000	127,000	320,000	241,000	375,000	494,000	1,228,000	277,000	810,000	88,000	208,000	145,000	401,000
October, ...	243,000	1,509,000	245,000	282,000	647,000	950,000	689,000	347,000	367,000	530,000	1,382,000	158,000	90,000	68,000	536,000
November, . . .	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	442,000	749,000	2,540,000	125,000	363,000	354,000	819,000
December, . . .	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000	954,000	440,000	1,018,000	794,000	1,961,000	387,000	537,000	391,000	1,274,000
Average for year, .	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,025,000	926,000	1,043,000	1,180,000	847,000	918,000	828,000	1,137,000
Average for driest six months, . . .	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000	413,000	541,000	613,000	725,000	238,000	270,000	201,000	578,000

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[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent. in 1904, to 4.1 per cent. in 1905, to 5.1 per cent. in 1906, to 6.0 per cent. in 1907, to 7.0 per cent. in 1908, 1909 and 1910.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1910.*

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
January,	103,000	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	995,000	1,235,000	1,461,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000	4,801,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000	1,815,000	1,947,000
May,	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000	1,336,000	720,000
June,	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	426,000	203,000
July,	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000	116,000
August,	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000	240,000	94,000
September,	207,000	184,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000	117,000
October,	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000	146,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	206,000	175,000	1,177,000	673,000
December,	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000	1,020,000
Average for year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,129,000	901,000	1,087,000
Average for driest six months,	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000	200,000	391,000	223,000

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1910* — Continued.

MONTH.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.
January,	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	693,000	1,034,000	1,064,000	845,000	1,638,000
February,	2,829,000	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000	2,676,000	1,067,000	3,022,000
March,	2,868,000	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000	2,604,000
April,	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000	1,829,000
May,	1,009,000	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	636,000	360,000	915,000	1,246,000
June,	413,000	421,000	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000	962,000	530,000
July,	115,000	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000	658,000	231,000
August,	214,000	379,000	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000	591,000	1,107,000
September,	111,000	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000	182,000	369,000
October,	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000	94,000	1,160,000
November,	369,000	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000	909,000	1,986,000
December,	643,000	3,043,000	2,241,000	996,000	544,000	485,000	796,000	716,000	1,782,000	657,000	1,584,000	1,799,000
Average for year,	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000	991,000	1,450,000
Average for driest six months,	234,000	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000	564,000	777,000

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times are not included in the above percentages of water surfaces.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1910* — Concluded.

MONTH.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	Mean for 36 Years, 1875–1910
January,	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,351,000	1,925,000	392,000	1,490,000	1,228,000
February,	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000	330,000	1,041,000	624,000	1,536,000	2,286,000	1,849,000	1,764,000
March,	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000	2,257,000	1,734,000	1,954,000	2,836,000
April,	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000	1,643,000	1,949,000	1,607,000	1,117,000	1,721,000	667,000	2,005,000
May,	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000	297,000	1,059,000	888,000	1,046,000	1,004,000	277,000	1,078,000
June,	66,000	316,000	753,000	303,000	1,987,000	419,000	467,000	707,000	761,000	194,000	239,000	516,000	515,000
July,	19,000	—18,000	306,000	66,000	445,000	62,000	177,000	398,000	9,000	—14,000	—121,000	—102,000	171,000
August,	—35,000	—34,000	424,000	135,000	307,000	170,000	114,000	180,000	—104,000	102,000	—45,000	—73,000	247,000
September,	94,000	65,000	305,000	178,000	130,000	397,000	1,246,000	19,000	541,000	—82,000	149,000	5,000	251,000
October,	115,000	186,000	412,000	506,000	492,000	191,000	158,000	301,000	741,000	47,000	—51,000	—51,000	454,000
November,	304,000	663,000	474,000	444,000	363,000	289,000	279,000	483,000	1,998,000	71,000	82,000	176,000	810,000
December,	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000	887,000	659,000	2,032,000	136,000	263,000	221,000	1,019,000
Average for year,	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000	795,000	860,000	1,010,000	694,000	625,000	570,000	1,027,000
Average for driest six months,	93,000	194,000	445,000	271,000	388,000	228,000	403,000	341,000	471,000	44,000	40,000	29,000	406,000

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land — which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, due to unavoidable inaccuracies in the measurement of the quantity of water received from the Wachusett Reservoir.

TABLE No. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1910.*

[Watershed above dam = 118.19 square miles].

MONTH.	Quantity of Water discharged through Wachusett Aqueduct (Gallons per Day).[1]	Quantity of Water wasted into River below Dam (Gallons per Day).	STORAGE.[2]		Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
			Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	83,661,000	1,558,000	132,184,000	-	218,197,000	5.86	3.293	56.2
February,	82,096,000	1,714,000	133,350,000	-	218,000,000	5.24	2.972	56.7
March,	77,174,000	1,710,000	232,103,000	-	311,958,000	1.09	4.709	432.8
April,	107,350,000	1,523,000	12,357,000	-	122,207,000	3.01	1.785	59.2
May,	93,697,000	5,045,000	-	27,816,000	71,910,000	2.13	1.085	50.9
June,	100,527,000	1,097,000	-	5,263,000	97,343,000	4.36	1.422	32.6
July,	131,900,000	2,023,000	-	127,574,000	7,310,000	1.52	0.110	7.2
August,	121,616,000	1,974,000	-	102,539,000	21,965,000	3.87	0.331	8.6
September,	111,493,000	1,943,000	-	97,210,000	17,107,000	2.86	0.250	8.7
October,	110,442,000	2,461,000	-	105,645,000	8,087,000	1.40	0.122	8.7
November,	97,823,000	2,280,000	-	59,020,000	41,883,000	4.17	0.612	14.7
December,	119,694,000	1,855,000	-	76,103,000	46,210,000	2.34	0.697	29.8
Total,	-	-	-	-	-	37.85	17.388	-
Average for year,	103,283,000	2,106,000	-	8,431,000	97,850,000	-	-	45.9

[1] Including 137,000 gallons per day drawn from aqueduct for the supply of the Westborough Insane Hospital.

[2] Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1910* — Concluded.

MONTH.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	Mean for 36 Years, 1875–1910
January, ...	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,351,000	1,925,000	392,000	1,490,000	1,228,000
February, ...	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000	330,000	1,041,000	624,000	1,536,000	2,286,000	1,849,000	1,764,000
March, ...	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000	2,257,000	1,734,000	1,954,000	2,836,000
April, ...	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000	1,643,000	1,949,000	1,607,000	1,117,000	1,721,000	667,000	2,005,000
May, ...	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000	297,000	1,059,000	888,000	1,046,000	1,004,000	277,000	1,078,000
June, ...	66,000	316,000	753,000	303,000	1,987,000	419,000	467,000	707,000	761,000	194,000	239,000	516,000	515,000
July, ...	19,000	—18,000	306,000	66,000	445,000	62,000	177,000	398,000	9,000	—14,000	—121,000	—102,000	171,000
August, ...	—35,000	—34,000	424,000	135,000	307,000	170,000	114,000	180,000	—104,000	102,000	—45,000	—73,000	247,000
September, ...	94,000	65,000	305,000	178,000	130,000	397,000	1,246,000	19,000	541,000	—82,000	149,000	5,000	251,000
October, ...	115,000	186,000	412,000	506,000	492,000	191,000	158,000	301,000	741,000	47,000	—51,000	—51,000	454,000
November, ...	304,000	663,000	474,000	444,000	363,000	289,000	279,000	483,000	1,998,000	71,000	82,000	176,000	810,000
December, ...	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000	887,000	659,000	2,032,000	136,000	263,000	221,000	1,019,000
Average for year, ...	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000	795,000	860,000	1,010,000	694,000	625,000	570,000	1,027,000
Average for driest six months,	93,000	194,000	445,000	271,000	388,000	228,000	403,000	341,000	471,000	44,000	40,000	29,000	406,000

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land — which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, due to unavoidable inaccuracies in the measurement of the quantity of water received from the Wachusett Reservoir.

TABLE NO. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1910.*

[Watershed above dam = 118.19 square miles].

MONTH.	Quantity of Water discharged through Wachusett Aqueduct (Gallons per Day).[1]	Quantity of Water wasted into River below Dam (Gallons per Day).	STORAGE.[2]		Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
			Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	83,661,000	1,558,000	132,184,000	-	218,197,000	5.86	3.293	56.2
February,	82,096,000	1,714,000	133,350,000	-	218,000,000	5.24	2.972	56.7
March,	77,174,000	1,710,000	232,103,000	-	311,958,000	1.09	4.709	432.8
April,	107,350,000	1,523,000	12,357,000	-	122,207,000	3.01	1.785	59.2
May,	93,697,000	5,045,000	-	27,816,000	71,910,000	2.13	1.085	50.9
June,	100,527,000	1,097,000	-	5,263,000	97,343,000	4.36	1.422	32.6
July,	131,900,000	2,023,000	-	127,574,000	7,310,000	1.52	0.110	7.2
August,	121,616,000	1,974,000	-	102,539,000	21,965,000	3.87	0.331	8.6
September,	111,493,000	1,943,000	-	97,210,000	17,107,000	2.86	0.250	8.7
October,	110,442,000	2,461,000	-	105,645,000	8,087,000	1.40	0.122	8.7
November,	97,823,000	2,280,000	-	59,020,000	41,883,000	4.17	0.612	14.7
December,	119,694,000	1,855,000	-	76,103,000	46,210,000	2.34	0.697	29.8
Total,	-	-	-	-	-	37.85	17.388	-
Average for year,	103,283,000	2,106,000	-	8,431,000	97,850,000	-	-	45.9

[1] Including 137,000 gallons per day drawn from aqueduct for the supply of the Westborough Insane Hospital.

[2] Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE No. 10. — *Sudbury System.* — *Statistics of Flow of Water, Storage and Rainfall in 1910.*

[Watershed from 1875 to 1878 inclusive=77.764 square miles; in 1879 and 1880=78.238 square miles; and from 1881 to 1910 inclusive=75.2 square miles.]

MONTH.	Quantity of Water received through Wachusett Aqueduct (Gallons per Day).[1]	Quantity of Water discharged through Sudbury Aqueduct (Gallons per Day).	Quantity of Water discharged through Weston Aqueduct (Gallons per Day).	Quantity of Water used by Framingham Water Works (Gallons per Day).	Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day).	Quantity of Water wasted into River below Lowest Dam (Gallons per Day).	STORAGE.		Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
							Gain (Gallons per Day).	Loss (Gallons per Day).				
January, . .	83,539,000	96,016,000	29,145,000	603,000	1,003,000	74,052,000	-	5,261,000	112,019,000	5.39	2.657	49.3
February, .	81,982,000	92,586,000	28,986,000	589,000	1,461,000	78,357,000	19,039,000	-	139,036,000	5.06	2.979	58.9
March, . .	77,065,000	83,865,000	28,706,000	545,000	1,587,000	118,929,000	-	9,626,000	146,942,000	0.85	3.486	408.7
April, . .	107,240,000	80,253,000	29,127,000	540,000	903,000	36,710,000	9,840,000	-	50,133,000	2.75	1.151	41.9
May, . .	93,587,000	79,790,000	29,274,000	545,000	787,000	9,116,000	-	5,071,000	20,855,000	1.29	0.495	38.3
June, . .	100,400,000	81,357,000	28,833,000	603,000	760,000	31,667,000	-	3,993,000	38,827,000	4.68	0.891	19.0
July, . .	131,732,000	92,906,000	29,355,000	748,000	484,000	1,958,000	-	1,410,000	—7,690,000	2.03	—0.182	—9.0
August, . .	121,458,000	87,845,000	29,419,000	606,000	468,000	1,500,000	-	3,848,000	—5,468,000	2.62	—0.130	—5.0
September, .	111,333,000	82,293,000	28,330,000	607,000	497,000	1,500,000	-	1,523,000	370,000	2.49	0.008	0.3
October, . .	110,281,000	79,219,000	28,726,000	665,000	413,000	1,500,000	-	4,055,000	—3,813,000	1.86	—0.091	—4.9
November, .	97,670,000	71,250,000	28,710,000	670,000	580,000	9,573,000	143,000	-	13,257,000	4.13	0.304	7.4
December, .	119,542,000	92,942,000	29,052,000	790,000	697,000	11,558,000	1,145,000	-	16,642,000	2.49	0.395	15.8
Total, .	-	-	-	-	-	-	-	-	-	35.64	11.963	-
Av. for year,	103,145,000	85,033,000	28,974,000	627,000	799,000	31,108,000	-	561,000	42,835,000	-	-	33.6

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[1] Not including 137,000 gallons per day drawn through Wachusett Aqueduct for the supply of the Westborough Insane Hospital, which were not discharged into Sudbury Reservoir.

TABLE NO. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1910.*

[Watershed of lake = 17.80 square miles.[1]]

MONTH.	Quantity of Water discharged through Cochituate Aqueduct (Gallons per Day).	Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day).	Quantity of Water wasted at Outlet of Lake (Gallons per Day).	STORAGE.		Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
				Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	-	958,000	-	26,926,000	-	27,884,000	5.11	2.80	54.7
February,	-	1,157,000	23,929,000	7,204,000	-	32,289,000	5.16	2.92	56.7
March,	-	516,000	31,716,000	-	4,487,000	27,745,000	0.77	2.78	361.1
April,	-	653,000	27,297,000	-	14,757,000	13,193,000	2.71	1.28	47.2
May,	-	429,000	6,226,000	281,000	-	6,935,000	1.33	0.70	52.3
June,	-	430,000	19,580,000	-	8,230,000	11,780,000	4.51	1.14	25.3
July,	-	68,000	4,539,000	-	1,713,000	2,894,000	2.23	0.29	13.0
August,	-	155,000	-	-	-	155,000	1.58	0.02	1.0
September,	-	140,000	-	1,020,000	-	1,160,000	2.50	0.11	4.5
October,	-	74,000	-	329,000	-	403,000	1.80	0.04	2.2
November,	-	133,000	-	4,223,000	-	4,357,000	4.16	0.42	10.2
December,	-	297,000	-	5,529,000	-	5,826,000	2.61	0.58	22.4
Total,	-	-	-	-	-	-	34.47	13.08	-
Average for year,	-	412,000	9,296,000	1,376,000	-	11,065,000	-	-	37.9

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[1] Not including the watersheds of Dudley and Dug ponds.

TABLE NO. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE.	Chestnut Hill Reservoir. Ordinary High Water =134.00.	Lake Cochituate. High Water =144.36.	Farm Pond. High Water =159.25.	Spot Pond. High Water =163.00.	Weston Reservoir. High Water =200.00.	FRAMINGHAM RESERVOIR.			Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Flash Boards 259.97.	Hopkinton Reservoir. Flash Boards 305.00.	Whitehall Reservoir. Ordinary High Water =337.91.	Wachusett Reservoir. Ordinary High Water =395.00.
						No. 1. Flash Boards 169.27.	No. 2. Flash Boards 177.12.	No. 3. Flash Boards 186.50.					
Jan. 1, 1910, .	133.42	138.76	157.58	162.86	200.00	167.65	175.99	182.41	224.35	259.28	304.12	337.24	382.09
Feb. 1, 1910, .	134.03	142.69	158.21	163.22	200.68	168.05	176.34	183.54	224.11	259.19	302.97	336.22	385.14
Mar. 1, 1910, .	134.11	143.54	158.71	162.80	200.12	168.60	176.85	186.56	223.93	259.52	304.00	336.36	388.20
April 1, 1910, .	133.98	142.96	158.51	163.02	200.00	167.92	176.15	185.50	224.44	259.27	304.17	335.96	393.72
May 1, 1910, .	133.82	140.97	158.31	162.98	199.98	167.82	176.13	184.81	224.46	260.02	304.25	336.19	393.99
June 1, 1910, .	133.71	141.01	158.01	162.89	200.08	169.41	177.18	184.19	225.35	259.25	304.85	336.34	393.48
July 1, 1910, .	133.57	139.84	157.99	162.75	200.00	165.46	177.09	184.00	225.27	259.25	305.03	336.64	393.39
Aug. 1, 1910, .	134.38	139.58	157.63	162.57	200.02	166.75	176.50	184.24	225.10	259.31	304.61	336.35	390.64
Sept. 1, 1910, .	133.91	139.58	157.31	162.82	200.00	167.12	176.56	184.00	225.09	259.22	304.12	336.18	388.26
Oct. 1, 1910, .	133.84	139.73	157.22	162.81	199.97	167.60	177.00	182.94	225.05	259.24	304.05	336.19	386.05
Nov. 1, 1910, .	134.01	139.78	157.05	162.14	199.91	167.46	176.94	182.26	224.89	259.20	303.93	336.07	383.36
Dec. 1, 1910, .	133.95	140.39	157.25	161.37	200.05	167.68	175.99	182.76	224.40	259.22	304.11	336.04	381.66
Jan. 1, 1911, .	133.70	141.19	157.42	162.66	200.07	167.74	176.06	183.64	224.40	259.25	304.16	335.70	379.35

TABLE No. 13. — *Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.*

From Wachusett Reservoir into Sudbury Reservoir.

7:00 A.M. Jan. 1, 1910 to 10:15 A.M. Jan. 7, 1910.
7:00 A.M. Jan. 8, 1910 " 9:30 A.M. Jan. 22, 1910.
7:05 A.M. Jan. 26, 1910 " 11:00 A.M. Jan. 26, 1910.
10:00 P.M. Jan. 26, 1910 " 10:10 A.M. Feb. 17, 1910.
11:10 A.M. Feb. 18, 1910 " 11:00 A.M. Feb. 21, 1910.
1:00 P.M. Feb. 24, 1910 " 10:00 A.M. Feb. 28, 1910.
2:00 P.M. Mar. 10, 1910 " 9:30 A.M. Apr. 13, 1910.
10:00 A.M. Apr. 14, 1910 " 7:15 A.M. Apr. 26, 1910.
3:00 P.M. Apr. 26, 1910 " 10:30 A.M. June 10, 1910.
12:00 N. June 11, 1910 " 10:30 A.M. July 12, 1910.
5:30 P.M. July 12, 1910 " 10:00 A.M. July 13, 1910.
3:00 P.M. July 13, 1910 " 6:00 A.M. July 23, 1910.
1:10 P.M. July 23, 1910 " 11:45 A.M. July 25, 1910.
5:10 P.M. July 25, 1910 " 6:00 A.M. July 26, 1910.
2:00 P.M. July 26, 1910 " 10:00 P.M. Dec. 4, 1910.
5:00 P.M. Dec. 5, 1910 " 10:00 P.M. Dec. 26, 1910.
5:00 P.M. Dec. 27, 1910 " 7:00 A.M. Jan. 1, 1911.
Total quantity, 37,698,200,000 gallons.

From Sudbury Reservoir through the Weston Aqueduct to the Weston Reservoir.

7:00 A.M. Jan. 1, 1910 to 7:00 A.M. Jan. 1, 1911.
Total quantity, 10,575,600,000 gallons.

From Framingham Reservoir No. 3 through Sudbury Aqueduct to Chestnut Hill Reservoir.

7:00 A.M. Jan. 1, 1910 to 7:00 A.M. Jan. 1, 1911.
Total quantity, 31,037,100,000 gallons.

TABLE No. 14. — *Average Daily Quantity of Water flowing through Aqueducts in 1910 by Months.*[1]

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons).
January,	83,539,000	29,145,000	96,016,000
February,	81,982,000	28,986,000	92,586,000
March,	77,065,000	28,706,000	83,865,000
April,	107,240,000	29,127,000	80,253,000
May,	93,587,000	29,274,000	79,790,000
June,	100,400,000	28,833,000	81,357,000
July,	131,732,000	29,355,000	92,906,000
August,	121,458,000	29,419,000	87,845,000
September,	111,333,000	28,330,000	82,293,000
October,	110,281,000	28,726,000	79,219,000
November,	97,670,000	28,710,000	71,250,000
December,	119,542,000	29,052,000	92,942,000
Average,	103,145,000	28,974,000	85,083,000

[1] Not including quantities wasted while cleaning and repairing aqueducts.

TABLE No. 15. — *Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill High-service Pumping Station for the Year 1910.*

[3 per cent. allowed for slip.]

MONTH.	ENGINE No. 1.			ENGINE No. 2.			Total Amount pumped (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	AVERAGE LIFT (FEET).		Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Total Pumping Time.		Amount pumped, corrected for Slip (Million Gallons).	Total Pumping Time.		Amount pumped, corrected for Slip (Million Gallons).						Engine No. 1.	Engine No. 2.		
	Hrs.	Min.		Hrs.	Min.										
January, ...	214	10	70.23	216	00	69.81	140.04	243,042	26,255	10.8	576.20	118.91	118.92	57,070,000	58,840,000
February, ...	235	35	83.63	117	35	40.18	123.81	207,654	24,118	11.6	596.23	119.47	120.74	59,540,000	61,390,000
March, ...	33	45	12.51	190	25	65.30	77.81	154,600	24,887	16.1	503.30	119.74	120.04	50,310,000	51,870,000
April, ...	151	15	53.94	173	45	61.08	115.02	169,697	25,630	15.1	677.80	121.20	120.79	68,310,000	70,430,000
May, ...	158	30	56.73	103	50	36.15	92.88	134,825	20,230	15.0	688.89	119.32	119.72	68,560,000	70,690,000
June, ...	301	45	110.75	-	-	-	110.75	147,694	19,885	13.5	749.86	118.91	-	74,280,000	76,590,000
July, ...	515	35	181.31	-	-	-	181.31	237,178	26,052	11.0	764.45	119.38	-	76,020,000	78,380,000
August, ...	359	25	122.76	-	-	-	122.76	185,480	18,840	10.2	661.85	119.17	-	65,700,000	67,740,000
September, ...	279	20	92.98	-	-	-	92.98	152,637	16,952	11.1	609.16	118.79	-	60,280,000	62,150,000
October, ...	142	50	48.28	110	50	36.90	85.18	150,175	15,625	10.4	567.20	118.97	119.33	56,280,000	58,030,000
November, ...	265	57	92.38	87	00	29.32	121.70	185,240	18,980	10.2	656.99	120.52	126.09	66,690,000	68,760,000
December, ...	-	-	-	337	00	113.47	113.47	199,802	22,800	11.4	567.91	-	119.46	56,510,000	58,270,000
Total, ...	2,658	07	925.50	1,336	25	452.21	1,377.71	2,168,024	260,254	-	-	-	-	-	-
Average, ...	-	-	-	-	-	-	-	-	-	12.0	635.47	119.41	120.19	63,340,000	65,310,000

TABLE No. 16. — *Statement of Operation of Engine No. 3 at Chestnut Hill High-service Pumping Station for the Year 1910.*

[4.4 per cent. allowed for slip.]

MONTH.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
January,	-	-	-	-	-	-	-	-	-	-
February,	-	-	-	-	-	-	-	-	-	-
March,	-	-	-	-	-	-	-	-	-	-
April,	95	45	81.46	86,956	10,487	12.1	936.80	129.05	100,700,000	105,320,000
May,	-	-	-	-	-	-	-	-	-	-
June,	-	-	-	-	-	-	-	-	-	-
July,	-	-	-	-	-	-	-	-	-	-
August,	-	-	-	-	-	-	-	-	-	-
September,	-	-	-	-	-	-	-	-	-	-
October,	-	-	-	-	-	-	-	-	-	-
November,	173	05	147.21	160,163	16,597	10.4	919.13	130.34	99,790,000	104,870,000
December,	-	-	-	-	-	-	-	-	-	-
Total,	268	50	228.67	247,119	27,084	-	-	-	-	-
Average,	-	-	-	-	-	11.0	925.34	129.88	100,110,000	104,710,000

TABLE No. 17. — *Statement of Operation of Engine No. 4 at Chestnut Hill High-service Pumping Station for the Year 1910.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	SUMMARY OF ENGINES NOS. 1, 2, 3 AND 4.	
											Total Amount pumped, corrected for Slip (Million Gallons).	Daily Average Amount pumped (Million Gallons).
	Hrs.	Min.										
January,	740	40	949.65	752,493	79,325	10.5	1,262.01	130.06	136,730,000	139,480,000	1,089.69	35.151
February,	668	50	858.05	661,802	62,363	9.4	1,296.54	131.06	141,550,000	144,400,000	981.86	35.067
March,	738	15	945.15	755,165	92,527	12.3	1,251.58	131.57	137,170,000	139,930,000	1,022.96	32.999
April,	620	20	793.77	641,673	80,725	12.6	1,237.03	130.05	134,010,000	136,700,000	990.25	33.008
May,	738	15	947.00	757,388	83,465	11.0	1,250.35	130.34	135,750,000	138,480,000	1,039.88	33.544
June,	718	15	921.21	741,409	87,960	11.9	1,242.51	130.53	135,100,000	137,820,000	1,031.96	34.399
July,	743	20	954.95	749,361	80,204	10.7	1,274.35	131.17	139,240,000	142,040,000	1,136.26	36.654
August,	741	05	951.44	731,995	73,630	10.1	1,299.79	130.98	141,820,000	144,670,000	1,074.20	34.652
September,	720	00	920.32	697,868	68,400	9.8	1,318.76	129.81	142,600,000	145,470,000	1,013.30	33.777
October,	742	15	951.58	720,695	71,405	9.9	1,320.36	130.77	143,830,000	146,720,000	1,036.76	33.444
November,	543	00	683.55	521,295	50,991	9.8	1,311.25	129.96	141,950,000	144,800,000	952.46	31.749
December,	741	35	948.03	736,733	80,220	10.9	1,286.80	130.43	139,810,000	142,620,000	1,061.50	34.242
Total,	8,455	50	10,824.70	8,467,877	911,215	-	-	-	-	-	12,431.08	-
Average,	-	-	-	-	-	10.8	1,278.33	130.58	139,050,000	141,840,000	-	34.058

TABLE No. 18. — *Statement of Operation of Engines Nos. 5, 6 and 7, at Chestnut Hill Low-service Pumping Station for the Year 1910.*

[2 per cent. allowed for slip.]

MONTH.	ENGINE No. 5.		ENGINE No. 6.		ENGINE No. 7.		Total Amount pumped (Million Gallons).	Daily Average Amount pumped (Million Gallons).	Total Amount of Coal consumed (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	AVERAGE LIFT (FEET).			Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).						Engine No. 5.	Engine No. 6.	Engine No. 7.		
	Hrs. Min.		Hrs. Min.		Hrs. Min.											
January,	698 15	768.47	726 15	800.19	232 55	312.04	1,880.70	60.668	692,495	10.3	2,715.83	49.61	49.76	35.31	107,010,000	109,200,000
February,	552 05	594.06	644 25	717.90	260 20	310.71	1,622.67	57.953	586,485	9.9	2,766.77	49.55	48.84	28.65	104,250,000	106,390,000
March,	479 30	524.50	616 55	711.89	326 10	346.07	1,582.46	51.047	585,570	10.4	2,702.43	50.35	49.44	25.25	100,070,000	102,120,000
April,	374 55	461.08	495 50	598.20	341 55	337.97	1,397.25	46.575	493,350	10.0	2,832.17	49.49	47.01	24.75	100,130,000	102,180,000
May,	500 40	578.46	550 10	595.84	256 05	254.01	1,428.31	46.075	578,230	10.0	2,470.14	56.64	57.45	29.46	107,290,000	109,490,000
June,	436 40	488.06	500 15	589.91	292 05	313.57	1,391.54	46.385	546,425	12.4	2,546.63	53.49	51.89	40.01	105,590,000	107,750,000
July,	589 05	652.01	737 30	812.37	170 40	185.79	1,650.17	53.231	671,380	12.1	2,457.88	56.64	56.79	52.68	115,200,000	117,560,000
August,	661 35	682.55	702 00	728.00	179 45	207.14	1,617.69	52.184	652,855	12.4	2,477.87	55.70	55.83	28.16	107,810,000	110,020,000
September,	550 20	623.62	566 05	651.21	143 45	147.35	1,422.18	47.406	542,220	10.5	2,622.88	51.60	51.30	21.36	105,590,000	107,750,000
October,	586 35	676.01	293 00	351.63	370 20	343.75	1,371.39	44.238	525,320	8.3	2,610.58	56.55	53.21	19.41	100,870,000	102,940,000
November,	30 40	29.93	720 00	810.34	439 10	363.42	1,203.69	40.123	500,845	8.9	2,403.32	61.43	61.57	19.06	97,560,000	99,560,000
December,	723 40	804.83	728 00	811.72	169 15	209.92	1,826.47	58.918	747,215	10.9	2,444.37	58.02	57.95	23.72	110,050,000	112,310,000
Total,	6,184 00	6,883.58	7,280 25	8,179.20	3,182 25	3,331.74	18,394.52	–	7,122,390	–	–	–	–	–	–	–
Average,	– –	–	– –	–	– –	–	–	50.396	–	10.6	2,582.63	53.69	53.66	28.33	105,590,000	107,750,000

TABLE No. 19. — *Statement of Operation of Engine No. 8 at Spot Pond Pumping Station for the Year 1910.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	13	00	5.60	5,651	965	17.1	990.98	119.36	98,530,000	100,560,000
February,	-	-	-	-	-	-	-	-	-	-
March,	14	00	6.12	6,186	1,034	16.7	989.33	121.89	100,450,000	102,520,000
April,	14	00	6.11	6,100	1,120	18.4	1,001.64	121.03	100,980,000	103,060,000
May,	-	-	-	-	-	-	-	-	-	-
June,	29	00	12.20	12,317	2,206	17.9	990.50	124.83	103,000,000	105,120,000
July,	-	-	-	-	-	-	-	-	-	-
August,	15	30	7.02	6,840	975	14.3	1,026.32	120.60	103,100,000	105,220,000
September,	-	-	-	-	-	-	-	-	-	-
October,	63	45	27.70	28,036	2,110	7.5	988.02	119.73	98,540,000	100,600,000
November,	12	00	5.38	6,330	935	14.8	849.92	121.94	86,330,000	88,110,000
December,	-	-	-	-	-	-	-	-	-	-
Total,	161	15	70.13	71,460	9,345	-	-	-	-	-
Average,	-	-	-	-	-	13.1	981.39	121.15	99,040,000	101,080,000

TABLE No. 20. — *Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1910.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	SUMMARY OF ENGINES NOS. 8 AND 9.	
											Total Amount pumped, corrected for Slip (Million Gallons).	Daily Average Amount pumped (Million Gallons).
	Hrs.	Min.										
January,	259	45	215.47	188,576	22,943	12.2	1,142.62	130.39	124,110,000	126,630,000	221.07	7.131
February,	243	40	201.53	178,564	22,497	12.6	1,128.61	131.50	123,630,000	126,140,000	201.53	7.197
March,	254	15	208.93	186,279	23,485	12.6	1,121.60	131.25	122,630,000	125,120,000	215.05	6.937
April,	241	50	201.97	180,583	24,948	13.8	1,118.43	131.47	122,480,000	124,970,000	208.08	6.936
May,	273	20	228.67	224,027	32,899	14.7	1,020.73	132.43	112,600,000	114,890,000	228.67	7.376
June,	269	00	223.07	193,385	30,429	15.7	1,153.50	130.61	125,500,000	128,050,000	235.27	7.842
July,	359	30	299.52	247,560	34,927	14.1	1,209.89	131.58	132,610,000	135,300,000	299.52	9.662
August,	314	15	262.85	217,707	25,478	11.7	1,207.36	130.08	130,830,000	133,490,000	269.87	8.705
September,	271	40	227.97	189,177	21,557	11.4	1,205.06	129.96	130,460,000	133,110,000	227.97	7.599
October,	232	15	196.36	167,413	19,130	11.4	1,172.91	131.14	128,130,000	130,730,000	224.06	7.228
November,	237	00	197.50	173,953	19,842	11.4	1,135.36	132.86	125,650,000	128,200,000	202.88	6.763
December,	261	45	218.14	195,230	23,919	12.3	1,117.35	131.13	122,050,000	124,530,000	218.14	7.037
Total,	3,218	15	2,681.98	2,342,454	302,054	–	–	–	–	–	2,752.11	–
Average,	–	–	–	–	–	12.9	1,144.94	131.18	125,110,000	127,650,000	–	7.540

TABLE No. 21. — (*Meter Basis.*) *Average Daily Consumption of Water during the Year 1910, in the Cities and Towns supplied by the Metropolitan Water Works, including Boston, Somerville, Chelsea, Malden, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Lexington, Milton, Stoneham, Winthrop, Swampscott, Belmont and Nahant.* (*For Consumption of Water in Whole Metropolitan Water District, see Table No. 24.*)

MONTH.	Average Daily Consumption (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
January,	123,249,800	1,008,340	122
February,	123,890,200	1,010,350	123
March,	111,156,600	1,012,400	110
April,	106,842,500	1,014,610	105
May,	107,454,700	1,017,510	106
June,	109,031,100	1,020,330	107
July,	116,950,000	1,027,850	114
August,	111,973,800	1,028,120	109
September,	107,788,600	1,027,940	105
October,	106,881,000	1,027,500	104
November,	103,343,800	1,028,880	100
December,	117,015,000	1,030,960	114
For the year,	112,092,100	1,022,230	110

In addition to the above quantities, the United States Government Reservation on Peddocks Island was supplied with 31,191,300 gallons, equivalent to a daily average rate of 85,400 gallons, and a part of Saugus with 6,003,000 gallons, equivalent to a daily average rate of 16,500 gallons.

TABLE No. 22. — (*Meter Basis.*) *Average Daily Consumption of Water in Gallons, from the Low-service System in 1910.*

MONTH.	SOUTHERN LOW SERVICE.	NORTHERN LOW SERVICE.	Total Low-service Consumption.
	Boston, excluding East Boston and Charlestown.	Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington.	
January,	52,008,400	29,341,300	81,349,700
February,	52,117,200	29,847,800	81,965,000
March,	45,794,400	25,807,200	71,601,600
April,	43,047,100	24,374,300	67,421,400
May,	41,733,600	25,083,900	66,817,500
June,	41,526,700	25,628,700	67,155,400
July,	43,641,900	27,356,100	70,998,000
August,	42,837,100	25,988,400	68,825,500
September,	41,869,400	24,635,000	66,504,400
October,	41,724,200	24,242,100	65,966,300
November,	41,642,300	23,258,700	64,901,000
December,	48,406,200	27,016,300	75,422,500
For the year,	44,667,600	26,032,400	70,700,000

TABLE No. 23. — (*Meter Basis.*) *Average Daily Consumption of Water, in Gallons, from the High-service and Extra High-service Systems in 1910.*

MONTH.	SOUTHERN HIGH SERVICE.	SOUTHERN EXTRA HIGH SERVICE.	NORTHERN HIGH SERVICE.	NORTHERN EXTRA HIGH SERVICE.
	Quincy, Watertown, and Portions of Boston, Belmont and Milton.	Portions of Boston and Milton.	Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford and Somerville.	Lexington and Portions of Arlington and Belmont.
January,	33,789,700	567,800	6,930,700	611,900
February,	33,602,900	612,500	7,057,100	652,700
March,	31,694,600	614,600	6,631,700	614,100
April,	31,378,500	623,800	6,716,500	702,300
May,	32,169,800	682,300	7,013,800	771,300
June,	32,816,400	709,000	7,587,300	763,000
July,	34,946,300	856,700	9,023,100	1,125,900
August,	32,922,500	794,100	8,476,000	955,700
September,	32,402,700	708,800	7,346,900	825,800
October,	32,276,200	705,100	7,124,500	808,900
November,	30,406,600	651,100	6,679,000	706,100
December,	33,330,900	640,100	6,883,400	738,100
For the year,	32,644,400[1]	681,000	7,292,600[2]	774,100

In addition to the above [1] the United States Government Reservation on Peddocks Island was supplied with a daily average rate of 85,400 gallons, and [2] part of Saugus with a daily average rate of 16,500 gallons.

TABLE NO. 24. — *Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works, as measured by Venturi Meters in 1910.*

City or town,	BOSTON.		SOMERVILLE.		MALDEN.		CHELSEA.		EVERETT.		QUINCY.		MEDFORD.	
Population supplied,	674,400.		77,640.		44,730.		32,540.		33,710.		32,870.		23,330.	
MONTH.	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	98,972,100	148	6,497,200	85	1,808,600	41	3,013,700	93	2,898,000	87	2,458,900	76	1,570,400	68
February,	99,226,600	149	6,451,100	84	1,823,000	41	3,113,000	96	2,942,700	88	2,440,800	75	1,583,700	69
March,	88,220,600	132	5,906,300	77	1,787,000	40	2,803,800	86	2,469,400	74	2,455,300	75	1,431,400	62
April,	84,165,200	126	5,734,600	74	1,750,800	39	2,619,900	81	2,405,600	72	2,501,000	77	1,366,900	59
May,	83,516,100	124	6,152,500	80	1,763,600	40	2,647,100	81	2,406,200	72	2,729,500	83	1,437,100	62
June,	84,070,500	125	6,202,300	80	1,901,400	43	2,726,900	84	2,515,000	75	2,979,500	91	1,422,400	61
July,	87,650,000	130	6,504,500	84	2,168,300	48	2,896,800	89	2,692,200	80	3,665,900	112	1,899,600	81
August,	84,596,800	125	6,211,500	80	2,133,800	48	2,888,900	89	2,585,200	77	3,521,000	107	1,542,100	66
September,	82,918,900	123	6,081,000	78	1,909,600	42	2,920,500	90	2,479,100	73	3,135,500	95	1,255,100	54
October,	82,298,800	121	6,256,400	80	1,894,000	42	2,775,200	85	2,473,000	73	3,055,500	92	1,257,100	53
November,	80,297,800	118	5,933,600	76	1,755,100	39	2,717,300	83	2,323,700	68	2,878,400	87	1,150,000	49
December,	92,777,700	136	6,355,300	81	1,786,900	39	2,907,200	89	2,733,900	80	2,843,200	85	1,155,000	49
For the year,	87,346,700	130	6,189,500	80	1,874,400	42	2,834,500	87	2,575,600	76	2,891,900	88	1,422,400	61

TABLE NO. 24. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

City or town,	MELROSE.		REVERE.		WATERTOWN.		ARLINGTON.		MILTON.		WINTHROP.	
Population supplied,	15,790.		18,500.		12,960.		11,270.		7,970.		10,290.	
MONTH.	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	897,000	57	1,260,600	70	763,600	60	798,500	72	268,000	34	588,000	59
February,	929,100	59	1,307,100	72	780,600	61	809,500	73	288,400	36	592,800	59
March,	922,500	59	1,143,500	63	803,100	62	786,600	70	315,300	40	563,300	56
April,	971,100	62	1,112,300	61	788,800	61	839,200	75	339,200	43	598,300	59
May,	1,022,900	65	1,162,000	63	837,800	65	927,100	83	351,300	44	635,100	62
June,	1,043,000	66	1,309,300	71	832,500	64	944,400	84	330,900	42	745,500	73
July,	1,092,300	69	1,597,800	86	1,135,500	88	1,423,300	126	360,900	45	959,200	93
August,	1,141,800	72	1,711,300	92	976,000	75	1,184,000	105	302,000	38	808,500	78
September,	1,041,700	66	1,376,400	74	907,300	70	961,500	85	275,700	34	652,300	63
October,	1,055,700	67	1,275,500	68	961,800	74	911,900	80	329,300	41	569,000	54
November,	977,400	62	1,147,100	61	865,500	66	809,900	71	289,900	36	546,700	52
December,	968,500	61	1,348,800	71	905,300	69	846,600	74	257,600	32	529,100	50
For the year,	1,005,700	64	1,313,400	71	880,800	68	938,200	83	309,200	39	649,500	63

May,	[illegible]	[illegible]	241,800	61	324.900	73	167,000	60	499,800	79	109,031,100	107

TABLE NO. 25. — (*Pump Basis.*) *Consumption of Water in the Metropolitan Water District, as constituted in the Year 1910, and a Small Section of the Town of Saugus, from 1893 to 1910.*

[Gallons per day.]

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.
January, ...	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000	83,880,000
February, ...	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000	87,475,000
March, ...	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000	85,468,000
April, ...	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000	76,574,000
May, ...	61,025,000	60,676,000	65,194,000	78,402,000	76,772,000	76,677,000
June, ...	63,374,000	68,329,000	69,905,000	77,639,000	77,952,000	83,463,000
July, ...	69,343,000	73,642,000	69,667,000	80,000,000	85,525,000	88,228,000
August, ...	66,983,000	67,995,000	72,283,000	78,537,000	84,103,000	87,558,000
September, ...	64,654,000	67,137,000	73,724,000	74,160,000	84,296,000	88,296,000
October, ...	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000	81,770,000
November, ...	61,204,000	62,231,000	64,881,000	71,933,000	72,762,000	78,177,000
December, ...	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000	86,355,000
Average, . . .	66,165,000	65,382,000	69,499,000	78,360,000	80,793,000	83,651,000
Population, ...	723,153	743,354	763,557	786,385	809,213	832,042
Per capita, ...	91.5	88.0	91.0	99.7	99.8	100.5

MONTH.	1899.	1900.	1901.	1902.	1903.	1904.
January, ...	96,442,000	100,055,000	111,275,000	118,435,000	125,176,000	137,771,000
February, ...	103,454,000	98,945,000	117,497,000	117,268,000	122,728,000	143,222,000
March, ...	90,200,000	97,753,000	105,509,000	108,461,000	111,977,000	123,334,000
April, ...	86,491,000	89,497,000	93,317,000	103,153,000	107,179,000	108,688,000
May, ...	89,448,000	87,780,000	95,567,000	106,692,000	111,589,000	111,715,000
June, ...	97,691,000	98,581,000	103,420,000	110,002,000	105,590,000	111,209,000
July, ...	96,821,000	107,786,000	106,905,000	108,340,000	107,562,000	113,584,000
August, ...	92,072,000	102,717,000	102,815,000	107,045,000	103,570,000	112,836,000
September, ...	91,478,000	103,612,000	102,103,000	107,752,000	106,772,000	114,188,000
October, ...	89,580,000	98,358,000	103,389,000	106,560,000	103,602,000	108,290,000
November, ...	86,719,000	93,648,000	101,324,000	105,175,000	103,477,000	108,054,000
December, ...	85,840,000	97,844,000	113,268,000	125,434,000	114,721,000	125,119,000
Average, . . .	92,111,000	98,059,000	104,645,000	110,345,000	110,277,000	118,114,000
Population, ...	854,870	877,698	892,740	907,780	922,820	937,860
Per capita, ...	107.8	111.7	117.2	121.6	119.5	125.9

TABLE No. 25. — (*Pump Basis.*) *Consumption of Water, etc.* — Concluded.

[Gallons per day.]

MONTH.	1905.	1906.	1907.	1908.	1909.	1910.
January,	130,878,000	126,093,000	137,730,000	132,376,000	133,275,000	127,568,000
February,	140,595,000	130,766,000	150,822,000	146,199,000	130,763,000	131,093,000
March,	120,879,000	123,570,000	134,202,000	128,884,000	126,842,000	117,078,000
April,	111,898,000	118,428,000	121,556,000	128,926,000	125,335,000	112,775,000
May,	115,804,000	122,404,000	123,502,000	131,040,000	123,305,000	112,073,000
June,	117,441,000	121,882,000	125,623,000	139,843,000	125,179,000	114,082,000
July,	124,769,000	118,726,000	128,779,000	138,232,000	126,765,000	122,743,000
August,	121,158,000	120,591,000	131,098,000	128,073,000	121,781,000	118,373,000
September,	120,103,000	121,685,000	124,751,000	129,972,000	118,043,000	112,434,000
October,	118,301,000	116,561,000	124,051,000	124,189,000	115,939,000	112,332,000
November,	116,693,000	113,746,000	119,627,000	117,119,000	111,664,000	107,528,000
December,	122,696,000	130,995,000	122,407,000	124,468,000	115,733,000	121,994,000
Average,	121,671,000	122,085,000	128,561,000	130,712,000	122,851,000	117,458,000
Population,	955,920	981,690	1,007,520	1,025,890	1,051,420	1,076,930
Per capita,	127.3	124.4	127.6	127.4	116.8	109.1

This table includes the water consumed in the cities and towns enumerated in Table No. 21, together with the water consumed in Newton and Hyde Park, which are included in the Metropolitan Water District, but have not been supplied from the Metropolitan Works. The populations for the years 1901 to 1909 were revised after the census of 1905 and of 1910 became available, and consequently the figures in the reports after 1904 and 1909 differ from those published in a corresponding table in the preceding annual reports.

TABLE NO. 26. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
				COLOR.						ALBUMINOID.							
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1910.																
83029	Jan. 4	V. slight.	None.	18	Faintly vegetable.	Faintly vegetable.	3.25	1.60	.0024	.0110	.0102	.0008	.25	.0010	.0000	.33	1.3
83298	Jan. 18	V. slight.	V. slight.	8	None.	V. faintly vegetable.	2.75	1.05	.0030	.0170	.0140	.0030	.25	.0010	.0000	.22	1.3
83523	Feb. 1	V. slight.	Slight.	22	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	2.75	1.20	.0046	.0246	.0224	.0022	.27	.0020	.0000	.51	0.6
83764	Feb. 15	None.	V. slight.	15	V. faintly vegetable.	Faintly vegetable.	2.95	1.05	.0020	.0104	.0086	.0018	.27	.0030	.0000	.37	1.3
84001	Mar. 3	V. slight.	V. slight.	22	V. faintly vegetable.	Faintly vegetable.	3.50	1.60	.0030	.0158	.0128	.0030	.29	.0020	.0000	.35	1.3
84172	Mar. 15	V. slight.	V. slight.	20	Faintly vegetable.	Faintly vegetable and unpleasant.	3.20	1.10	.0014	.0130	.0096	.0034	.26	.0020	.0000	.30	0.8
84566	Apr. 7	V. slight.	V. slight.	16	Faintly unpleasant.	Distinctly unpleasant.	2.70	0.95	.0014	.0134	.0114	.0020	.23	.0010	.0000	.37	1.3
84740	Apr. 19	V. slight.	Slight.	15	V. faintly vegetable.	Faintly vegetable.	3.00	1.05	.0014	.0106	.0100	.0006	.25	.0010	.0001	.24	1.3
84980	May 3	V. slight.	V. slight.	17	V. faintly vegetable.	V. faintly vegetable.	2.85	1.05	.0008	.0126	.0104	.0022	.25	.0010	.0001	.25	0.8
85184	May 17	V. slight.	V. slight.	12	V. faintly vegetable.	Faintly vegetable.	2.75	0.95	.0008	.0130	.0118	.0012	.25	.0020	.0000	.24	0.8
85534	June 7	V. slight.	Slight.	16	V. faintly vegetable.	Faintly vegetable.	3.10	1.10	.0006	.0110	.0088	.0022	.25	.0010	.0000	.24	0.8
85917	June 21	V. slight.	Slight.	13	V. faintly vegetable.	Faintly vegetable.	2.45	1.05	.0020	.0104	.0088	.0016	.28	.0010	.0000	.29	0.5
86106	July 5	V. slight.	V. slight.	13	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.05	1.00	.0010	.0102	.0092	.0010	.22	.0000	.0001	.28	0.8
86786	Aug. 2	V. slight.	V. slight.	11	V. faintly vegetable.	V. faintly vegetable.	3.55	1.55	.0014	.0104	.0094	.0010	.25	.0000	.0000	.22	1.0
87192	Aug. 23	V. slight.	V. slight.	11	Faintly vegetable.	Faintly vegetable.	3.05	1.10	.0014	.0150	.0134	.0016	.24	.0010	.0000	.28	0.8
87471	Sept. 6	V. slight.	Slight.	10	None.	V. faintly vegetable.	2.70	1.15	.0008	.0094	.0084	.0010	.25	.0000	.0000	.24	0.6
87798	Sept. 20	None.	V. slight.	13	V. faintly vegetable.	V. faintly vegetable.	2.75	1.00	.0010	.0138	.0126	.0012	.26	.0010	.0000	.24	0.8
88116	Oct. 4	V. slight.	V. slight.	9	V. faintly vegetable.	Faintly vegetable.	2.85	1.00	.0018	.0112	.0106	.0006	.26	.0000	.0000	.23	0.8
88442	Oct. 18	None.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	2.80	1.00	.0032	.0124	.0112	.0012	.26	.0000	.0000	.28	0.8
89021	Nov. 8	None.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	3.35	1.55	.0020	.0156	.0152	.0004	.26	.0020	.0000	.22	0.8
89423	Nov. 21	None.	V. slight.	11	None.	None.	3.60	1.60	.0020	0144	.0128	.0016	.26	.0000	.0000	.17	0.8
89626	Dec. 6	V. slight.	V. slight.	11	V. faintly vegetable.	V. faintly vegetable.	2.55	1.15	.0014	.0094	.0080	.0014	.26	.0010	.0000	.22	0.8
89905	Dec. 20	V. slight.	V. slight.	10	None.	V. faintly unpleasant.	2.20	1.00	.0020	.0148	.0138	.0010	.27	.0010	.0000	.23	0.8
Av.	....	....	....	14	....	....	2.94	1.17	.0018	.0130	.0115	.0016	.26	.0010	.0000	.28	0.9

TABLE No. 27. — *Chemical Examinations of Water from Sudbury Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
				COLOR.						ALBUMINOID.							
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		

TABLE No. 28. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				Nitrates.	Nitrites.		
				Platinum Standard.						Total.	Dissolved.	Suspended.					
	1910.																
83114	Jan. 10	None.	V. slight.	10	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.95	1.20	.0030	.0148	.0134	.0014	.38	.0010	.0001	.20	1.3
83472	Jan. 31	V. slight.	V. slight.	10	V. faintly unpleasant.	Faintly unpleasant.	2.70	1.00	.0020	.0134	.0126	.0008	.33	.0000	.0000	.16	1.3
83970	Mar. 2	V. slight.	V. slight.	10	None.	V. faintly vegetable.	3.50	1.10	.0040	.0162	.0116	.0046	.32	.0010	.0000	.19	1.3
84467	Apr. 4	V. slight.	Slight.	10	Faintly unpleasant and fishy.	Distinctly unpleasant and fishy.	2.90	1.30	.0022	.0156	.0114	.0042	.34	.0020	.0002	.21	1.3
84935	May 2	V. slight.	Slight, also scum.	9	Faintly unpleasant and fishy.	Distinctly unpleasant and fishy.	2.90	1.25	.0012	.0146	.0142	.0004	.35	.0010	.0000	.18	1.3
85487	June 6	V. slight.	V. slight.	10	V. faintly unpleasant.	Faintly unpleasant.	3.40	1.35	.0010	.0138	.0122	.0016	.34	.0000	.0001	.19	1.6
86063	July 5	V. slight.	V. slight.	10	V. faintly unpleasant.	V. faintly unpleasant.	4.45	1.70	.0010	.0162	.0138	.0024	-	.0000	.0000	.15	1.1
86707	Aug. 1	V. slight.	V. slight.	12	None.	V. faintly vegetable.	3.90	1.50	.0012	.0132	.0124	.0008	.31	.0000	.0000	.23	1.3
87499	Sept. 7	V. slight.	Slight.	11	V. faintly vegetable.	V. faintly vegetable.	3.45	1.10	.0008	.0136	.0108	.0028	.33	.0000	.0000	.22	1.1
88226	Oct. 10	V. slight.	V. slight.	5	Faintly unpleasant.	Distinctly unpleasant.	3.95	1.55	.0004	.0120	.0102	.0018	.33	.0000	.0000	.16	1.3
88967	Nov. 7	V. slight.	V. slight.	4	V. faintly vegetable.	V. faintly vegetable.	3.30	1.45	.0012	.0156	.0136	.0020	.31	.0000	.0000	.16	0.8
89613	Dec. 6	V. slight.	V. slight.	0	V. faintly vegetable.	V. faintly vegetable.	3.50	1.50	.0012	.0142	.0108	.0034	.32	.0000	.0000	.19	1.3
Av.	....	....	....	8	....	....	3.49	1.33	.0016	.0144	.0123	.0022	.33	.0004	.0000	.19	1.3

Table No. 29. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
				Platinum Standard.						Total.	Dissolved.	Suspended.					
83074	1910. Jan. 3	V. slight.	V. slight.	26	V. faintly vegetable.	Faintly vegetable.	6.05	1.85	.0032	.0214	.0172	.0042	.64	.0000	.0000	.33	2.2
83487	Jan. 31	V. slight.	Slight.	30	Distinctly unpleasant,	Decidedly unpleasant,	6.40	2.65	.0018	.0198	.0164	.0034	.63	.0030	.0000	.41	2.2

TABLE No. 30. — *Chemical Examinations of Water from a Tap at the State House, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
				COLOR.						ALBUMINOID.							
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1910.																
83008	Jan. 3	None.	V. slight.	16	None.	V. faintly vegetable.	2.40	1.00	.0024	.0118	.0112	.0006	.26	.0030	.0000	.18	1.3
83475	Jan. 31	None.	V. slight.	15	V. faintly vegetable.	Faintly vegetable.	3.05	1.35	.0026	.0120	.0100	.0020	.26	.0060	.0000	.22	1.3
83927	Feb. 28	V. slight.	V. slight.	17	Faintly vegetable.	Faintly vegetable.	4.10	2.00	.0026	.0110	.0096	.0014	.27	.0050	.0000	.25	1.3
84468	Apr. 4	V. slight.	Slight.	17	Faintly vegetable.	Faintly vegetable.	3.70	1.60	.0016	.0124	.0100	.0024	.32	.0090	.0002	.25	1.3
84932	May 2	V. slight.	Slight.	20	Faintly vegetable.	Faintly vegetable.	3.20	1.10	.0014	.0116	.0112	.0004	.32	.0080	.0000	.24	1.3
85478	June 6	V. slight.	Slight.	17	V. faintly vegetable.	V. faintly vegetable.	3.30	1.20	.0012	.0152	.0118	.0034	.29	.0020	0001	.27	1.3
86085	July 5	V. slight.	Slight.	12	Faintly vegetable.	Faintly vegetable.	3.25	1.25	.0010	.0144	.0112	.0032	.30	.0010	.0000	.19	0.8
86793	Aug. 4	V. slight.	Slight.	11	V. faintly vegetable.	V. faintly vegetable.	3.20	1.15	.0002	.0086	.0086	.0000	.29	.0000	.0001	.23	0.8
87477	Sept. 7	V. slight.	Slight.	12	Faintly vegetable.	Faintly vegetable.	2.95	1.00	.0002	.0108	.0098	.0010	.25	.0000	.0001	.23	0.8
88099	Oct. 4	V. slight.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	2.20	1.05	.0006	.0114	.0094	.0020	.26	.0010	.0000	.25	0.8
88886	Nov. 3	None.	V. slight.	10	V. faintly vegetable.	V. faintly vegetable.	2.70	1.00	.0010	.0114	.0102	.0012	.27	.0000	.0000	.21	1.3
89579	Dec. 5	V. slight.	V. slight.	10	None.	V. faintly vegetable.	2.55	1.15	.0008	.0108	.0092	.0016	.27	.0010	.0000	.16	1.3
Av.	....	....	....	14	....	....	3.05	1.24	.0013	.0118	.0102	.0016	.28	.0030	.0000	.22	1.1

Table No. 31. — *Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1910.*

[Parts per 100,000.]

Locality.	Samples Collected.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
						Albuminoid.							
		Platinum Standard.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
Quinepoxet River, Holden, ...	Semi-monthly, .	41	3.72	1.48	.0019	.0157	.0140	.0018	.38	.0029	.0000	.49	0.8
Stillwater River, Sterling, ...	Semi-monthly, .	36	3.72	1.52	.0017	.0139	.0119	.0016	.22	.0011	.0000	.43	0.9
Wachusett Reservoir, West Boylston, . . .	Semi-monthly, .	26	3.20	1.26	.0017	.0130	.0111	.0019	.26	.0015	.0000	.37	0.8
Wachusett Reservoir, Clinton, surface, . . .	Semi-monthly, .	14	2.94	1.17	.0018	.0130	.0115	.0016	.26	.0010	.0000	.28	0.9
Wachusett Reservoir, Clinton, bottom, . . .	Semi-monthly, .	12	2.91	1.21	.0025	.0109	.0095	.0015	.25	.0025	.0000	.28	0.9
Marlborough (Walker's Brook), ...	Monthly, . .	73	22.17	6.32	.4345	.0580	.0456	.0124	4.12	.0873	.0131	.89	7.0
Marlborough Brook filter-beds, effluent,	Monthly,	12	17.38	–	.0215	.0113	–	–	2.28	.2767	.0008	.22	5.9

TABLE No. 32. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1910.*

[Parts per 100,000.]

YEAR.	COLOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
	Nessler Standard.	Platinum Standard.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				Nitrates.	Nitrites.		
						Total.	Dissolved.	Suspended.					
1892, . .	.37	37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	-	1.9
1893, . .	.61	53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60	1.8
1894, . .	.69	58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
1895, . .	.72	59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69	0.7
1896, . .	.49	45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4
1897, . .	.65	55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64	1.6
1898, . .	.41	40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4
1899, . .	.23	28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.0137	.0001	.35	1.1
1900, . .	.24	29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.0076	.0001	.38	1.3
1901, . .	.24	29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.0173	.0001	.42	1.7
1902, . .	.26	30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.0092	.0000	.40	1.3
1903, . .	.25	29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.0142	.0001	.39	1.5
1904, . .	-	23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.0110	.0001	.37	1.5
1905, . .	-	24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.0083	.0001	.35	1.4
1906, . .	-	24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.0054	.0001	.36	1.3
1907, . .	-	22	3.83	1.40	.0013	.0129	.0109	.0020	.33	.0068	.0001	.32	1.3
1908, . .	-	19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.0092	.0001	.26	1.2
1909, . .	-	18	3.46	1.43	.0011	.0128	.0103	.0025	.28	.0034	.0000	.25	1.3
1910, . .	-	14	3.05	1.24	.0013	.0118	.0102	.0016	.28	.0030	.0000	.22	1.1

Note relating to Chemical Examinations of Water, Tables Nos. 26–32.

The chemical examinations contained in the tables were made by the State Board of Health. Previous to the year 1904 colors were determined by the Nessler standard, but the corresponding values by the platinum standard are also given, for the purpose of comparison with colors determined in the laboratory of the Metropolitan Water and Sewerage Board, as given in subsequent tables. The odor recorded is taken in such a way that it is a much stronger odor than would be noticed in samples drawn directly from a tap or collected directly from a reservoir. The important samples are collected and examined semi-monthly or monthly.

TABLE No. 33. — *Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1910, inclusive.*

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WACHUSETT RESERVOIR.		SUDBURY RESERVOIR.		LAKE COCHITUATE.		FRAMINGHAM RESERVOIR. No. 3.	FRAMINGHAM RESERVOIR. No. 2.	ASHLAND RESERVOIR.	HOPKINTON RESERVOIR.	WHITEHALL RESERVOIR.
	Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.	Surface.	Mid-depth.	Surface.	Surface.	Surface.
1898,	-	-	354	149	830	696	390	245	263	944	690
1899,	-	-	470	252	905	644	440	218	357	715	393
1900,	-	-	498	361	1,758	1,071	645	365	390	980	437
1901,	-	-	337	225	992	702	336	149	244	450	705
1902,	-	-	590	402	1,071	730	627	204	550	588	198
1903,	-	-	549	388	931	795	459	169	323	231	327
1904,	313	-	517	376	663	542	475	174	153	106	375
1905,	769	592	644	502	1,255	503	535	158	289	240	147
1906,	446	272	953	714	1,407	1,143	692	226	431	475	1,279
1907,	425	212	513	419	1,123	1,200	413	205	378	336	961
1908,	731	466	850	885	1,559	1,241	932	725	699	516	708
1909,	2,151	1,937	2,474	2,513	1,142	1,198	2,372	610	603	294	445
1910,	480	328	464	556	928	1,033	455	436	426	387	154
Mean,	759	635	709	596	1,120	884	675	299	393	482	525

NOTE. — A large growth of Asterionella originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE NO. 33. — *Microscopic Organisms in Water, etc.* — Concluded.

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WESTON RESERVOIR.	SPOT POND.	CHESTNUT HILL RESERVOIR.			TAPS.			
			SUDBURY AQUEDUCT.	COCHITUATE AQUEDUCT.	EFFLUENT GATE-HOUSE.	Southern Low Service.	Southern High Service.	Northern Low Service.	Northern High Service.
	Surface.	Surface.	Inlet.	Inlet.	No. 2.				
1898,	-	485	304	544	304	230	-	-	-
1899,	-	1,129	359	992	329	192	201	-	-
1900,	-	573	568	1,139	897	468	452	-	-
1901,	-	628	344	697	413	243	280	-	-
1902,	-	581	563	937	525	367	451	-	-
1903,	-	650	450	860	435	286	398	-	-
1904,	-	465	405	838	472	303	470	274	189
1905,	-	609	551	904	554	528	671	363	388
1906,	783	671	631	1,042	721	550	583	326	422
1907,	443	590	349	909	419	312	427	205	422
1908,	979	741	783	1,073	689	666	695	443	481
1909,	2,399	1,079	1,999	632	1,899	1,913	1,959	1,313	677
1910,	625	622	457	-	465	447	421	221	374
Mean,	1,046	679	597	881	625	500	584	449	422

NOTE. — A large growth of Asterionella originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 34. — *Number of Bacteria per Cubic Centimeter in Wat*
Parts of the Metropolitan Water Works, from 1898 to 1910,

[Averages of weekly determinations.]

Year.	Chestnut Hill Reservoir.			Southern
	Sudbury Aqueduct Terminal Chamber.	Cochituate Aqueduct.	Effluent Gate-house No. 2.	Low Servic 244 Boylsto Street.
1898,	207	145	111	96
1899,	224	104	217	117
1900,	248	113	256	188
1901,	225	149	169	162
1902,	203	168	121	164
1903,	76	120	96	126
1904,	347	172	220	176
1905,	495	396	489	231
1906,	231	145	246	154
1907,	147	246	118	130
1908,	162	138	137	136
1909,	198	229	119	150
1910,	216	-	180	178
Mean,	229	177	191	154

TABLE No. 35. — *Colors of Water from Various Parts of the Me*
Works in 1910. (Means of Weekly Determination

[Platinum Standard.]

Month.	Wachusett Reservoir.						Sudbury Reservoir.				Framingham Reservoir.	
											No. 2.	No. 3
	Surface.	Mid-depth.	Bottom.	Worcester Street Bridge.	Quinepoxet River.	Stillwater River.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Mid-depth.	Mid-depth.
January,	14	14	14	51	61	51	15	15	15	37	85	15
February,	21	16	16	54	61	53	18	19	19	20	89	23
March,	28	25	23	54	57	53	25	26	25	63	74	28
April,	18	20	21	42	54	48	23	23	23	22	95	24
May,	15	15	16	39	48	42	17	17	17	18	109	1
June,	16	16	17	34	71	45	17	17	17	24	112	1
July,	16	16	17	30	38	39	17	17	17	17	89	1
August,	16	17	18	18	31	27	16	17	17	17	72	1
September,	15	15	17	16	30	28	15	16	21	16	62	1
October,	14	14	15	15	34	26	14	14	14	14	50	1
November,	14	14	14	15	38	35	15	15	15	15	50	1
December,	12	12	13	16	34	30	13	13	13	14	47	1
Mean,	17	16	17	32	46	40	17	17	18	23	78	1

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[1] The colors given in this column represent the combined colors of the wate feeders. The color of each is determined monthly, and due weight is given, in to the sizes of the streams.

TABLE No. 35. — *Colors of Water, etc.* — Concluded.

[Platinum Standard.]

MONTH.	CHESTNUT HILL RESERVOIR.			SPOT POND.	FELLS RESERVOIR.	NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Inlet (Sudbury Aqueduct).	Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.	Mid-depth.	Effluent Gate-house.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	15	-	15	12	12	14	12	15	15
February	21	-	21	15	15	22	15	21	22
March,	26	-	26	16	16	26	16	27	27
April,	24	-	21	12	13	24	13	22	22
May,	18	-	17	9	10	17	10	17	17
June,	17	-	17	10	10	17	10	17	17
July,	17	-	17	10	10	17	10	17	17
August,	17	-	17	12	12	17	12	17	17
September,	15	-	15	12	12	16	12	16	17
October,	15	-	15	11	10	14	11	15	15
November,	14	-	14	12	12	14	12	14	14
December,	13	-	13	10	10	13	10	13	13
Mean,	18	-	17	12	12	18	12	18	18

TABLE No. 36. — *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1910. (Means of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high water mark.]

[Degrees Fahrenheit.]

MONTH.	WACHUSETT RESERVOIR.			SUDBURY RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET).				FRAMINGHAM RESERVOIR NO. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).			LAKE COCHITUATE (DEPTH AT PLACE OF OBSERVATION 62.0 FEET).		
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.
January,	33.8	34.3	34.8	33.4	34.8	35.5	34.3	33.5	33.7	34.2	34.9	37.2	37.5
February,	34.0	35.0	35.5	33.3	36.1	37.4	35.0	34.1	34.7	34.3	33.4	35.5	36.1
March,	36.0	36.8	38.0	38.5	39.0	39.3	37.3	39.1	39.2	39.4	38.0	39.0	38.8
April,	45.0	43.8	44.3	50.9	49.6	48.8	46.5	52.1	51.9	51.5	49.5	47.0	45.0
May,	54.6	51.4	49.6	58.3	57.4	56.4	52.1	61.1	60.2	59.5	59.4	51.4	48.9
June,	65.5	55.8	51.8	66.8	62.9	61.3	56.4	69.5	69.0	66.7	66.6	53.0	47.1
July,	75.0	56.7	53.7	74.6	69.0	64.9	59.5	77.1	76.7	76.0	77.0	53.5	49.0
August,	71.5	57.0	53.8	71.9	68.3	65.2	57.6	73.3	73.0	72.9	72.8	53.8	44.8
September,	70.0	64.0	54.0	66.8	65.4	64.3	58.0	67.1	64.5	67.0	66.3	53.0	45.9
October,	60.0	59.5	55.8	60.1	62.0	59.0	57.1	58.0	57.7	57.9	59.8	55.5	46.0
November,	48.0	47.8	47.6	45.5	45.7	46.8	45.1	42.8	42.0	42.7	45.4	46.8	44.2
December,	34.8	35.5	36.0	34.5	35.1	36.3	35.0	34.9	35.3	35.0	37.3	37.8	39.5
Mean,	52.4	48.1	46.2	52.9	52.1	51.3	47.8	53.6	53.2	53.1	53.4	46.9	43.6

TABLE NO. 36. — *Concluded.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.	SPOT POND (DEPTH AT PLACE OF OBSERVATION 28.0 FEET).			NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Effluent Gate-house No. 2.	Surface.	Mid-depth.	Bottom.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	37.0	34.8	34.9	35.6	39.3	38.0	39.8	39.2
February,	36.9	35.6	35.6	36.1	39.4	39.3	39.8	40.3
March,	41.5	38.9	39.4	39.5	41.4	41.3	43.9	43.6
April,	51.2	49.8	49.8	49.5	51.4	51.3	54.0	54.0
May,	58.1	57.8	57.7	56.8	57.6	57.7	59.4	59.6
June,	64.4	65.1	64.1	62.1	63.8	64.3	64.8	65.1
July,	77.6	75.3	74.6	66.5	73.4	73.6	75.9	76.4
August,	73.4	73.0	72.9	71.3	72.9	73.1	73.2	73.7
September,	67.6	68.1	67.3	67.1	67.3	67.0	67.4	68.3
October,	61.0	59.5	59.5	59.6	61.6	59.9	63.1	63.2
November,	44.2	45.5	45.6	45.9	51.4	47.2	47.8	48.8
December,	36.5	35.6	35.8	35.8	42.0	37.5	41.8	42.4
Mean,	54.1	53.8	53.1	52.2	55.1	54.2	55.9	56.2

TABLE NO. 37. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1910.*

[Degrees Farenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January,	56.0	—6.0	29.3	55.0	—12.0	27.8	51.0	—12.0	26.5
February,	59.0	—5.0	28.7	56.0	—7.0	27.2	53.0	—8.0	23.4
March,	78.0	14.0	41.8	77.0	12.0	41.7	77.0	12.0	39.2
April,	79.0	27.0	52.6	77.0	25.0	52.4	77.0	26.0	50.7
May,	89.0	34.0	58.3	87.0	32.0	57.6	82.0	36.0	56.2
June,	92.0	37.0	64.9	90.0	35.0	64.6	85.0	37.0	63.3
July,	95.0	52.0	74.4	96.0	50.0	73.2	92.0	52.0	71.7
August,	91.0	44.0	69.4	87.0	41.0	67.5	82.0	46.0	66.6
September,	84.0	37.0	63.5	82.0	32.0	62.7	80.0	40.0	60.3
October,	87.0	22.0	55.5	84.0	20.0	54.4	80.0	24.0	52.2
November,	62.0	19.0	39.3	60.0	15.0	38.3	58.0	19.0	37.9
December,	54.0	1.0	26.3	51.0	—2.0	24.6	49.0	2.0	23.8
Average,	-	-	50.3	-	-	49.3	-	-	47.7

TABLE NO. 38. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1910.*

	DIAMETER OF PIPES IN INCHES.													Total.
	60	48	42	36	30	24	20	16	14	12	10	8	6	
Total length owned and operated Jan. 1, 1910 (feet),	14,418	184,531	8,075	46,915	26,927	59,004	57,272	59,082	26	26,028	3,751	1,575	929	488,533
Gate valves in same, ...	-	49	-	44	28	42	39	70	1	82	17	13	19	404
Air valves in same, ...	9	111	3	35	5	26	34	30	-	10	1	-	-	264
Length laid or relaid during 1910 (feet), . .	12,234	1,549	-	3,470	754	355	98	8,516	-	313	12	286	4	27,591
Gate valves in same, ...	2	-	-	2	1	7	3	1	-	11	-	2	1	30
Air valves in same, ...	13	-	-	3	1	3	-	3	-	-	-	-	-	23
Length abandoned during 1910 (feet), . . .	-	3,419	-	38	-	2	59	16	-	276	16	36	20	3,882
Gate valves in same, ...	-	-	-	-	-	-	1	-	-	2	-	1	1	5
Air valves in same, ...	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Length owned and operated Jan. 1, 1911 (feet), .	26,652[1]	182,661	8,075	50,347	27,681	59,357	57,311	67,582	26	26,065	3,747	1,825	913	512,242[2]
Gate valves in same, ...	2	49	-	46	29	49	41	71	1	91	17	14	19	429
Air valves in same, ...	22	111	3	38	6	29	34	33	-	10	1	-	-	287

[1] Includes 17,583 feet of 60-inch, 3,357 feet of 36-inch and 730 feet of 30-inch pipe laid but not yet used.

[2] 97.02 miles.

This table does not include 10 feet of 48-inch and 292 feet of 36-inch pipe laid as temporary line in Harvard Square, Cambridge.

Table No. 39. — *Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1910.*

	Diameter of Pipes in Inches.	

TABLE NO. 40. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1910.*

BY WHOM OWNED.	INCHES.																			TOTAL.	
	60	48	42	40	36	30	28	24	20	18	16	14	12	10	8	7	6	5	4	Feet.	Miles.
Metropolitan Water Works, . .	26,652	182,661	8,075	-	50,347	27,681	-	59,357	57,311	-	67,582	26	26,065	3,747	1,825	-	913	-	-	512,242	97.02
Boston, . . .	-	39,175	16,813	23,104	44,804	98,937	244	77,482	95,017	-	217,108	-	1,258,713	196,103	655,574	-	1,254,094	-	64,125	4,041,293	765.40
Somerville, . .	-	-	-	-	-	-	-	-	3,596	367	3,537	8,037	83,032	51,181	99,560	-	202,574	-	20,498	472,382	89.47
Malden, . . .	-	-	-	-	-	-	-	-	-	-	-	9,152	64,834	27,595	77,603	-	212,787	-	60,741	452,712	85.74
Chelsea, . . .	-	-	-	-	-	-	-	-	-	-	5,176	-	4,974	39,820	27,610	-	135,936	-	7,949	221,465	41.94
Everett, . . .	-	-	-	-	-	-	-	2,484	2,900	-	2,233	806	5,570	39,502	22,031	-	137,236	-	30,600	243,362	46.09
Quincy, . . .	-	-	-	-	-	-	-	-	2,679	-	23,232	-	26,654	37,534	98,561	994	267,547	948	106,848	564,997	107.01
Medford, . .	-	-	-	-	-	-	-	-	673	-	6,775	9,598	26,452	37,738	78,161	-	107,116	-	32,941	299,454	56.71
Melrose, . . .	-	-	-	-	-	-	-	-	-	-	5,223	2,920	22,986	19,016	24,249	-	130,405	-	53,506	258,305	48.92
Revere,[1] . .	-	-	-	-	-	-	-	-	-	-	22,650	5,700	19,280	14,550	17,503	-	56,779	-	75,522	211,984	40.15
Watertown, . .	-	-	-	-	-	-	-	-	-	-	400	11,877	5,959	4,644	19,861	-	120,206	-	12,666	175,613	33.26
Arlington, . .	-	-	-	-	-	-	-	-	-	-	-	-	31,804	21,621	32,742	-	94,517	-	22,602	203,286	38.50
Milton, . . .	-	-	-	-	-	-	-	-	-	-	103	44	22,548	20,935	50,860	-	122,999	-	15,982	233,471	44.22
Winthrop, . .	-	-	-	-	-	-	-	-	-	-	-	-	4,049	23,297	30,339	-	35,935	-	62,531	156,151	29.57
Stoneham, . .	-	-	-	-	-	-	-	-	-	-	-	-	4,525	4,725	3,775	-	94,189	-	13,438	120,652	22.85
Belmont, . .	-	-	-	-	-	-	-	-	-	-	-	-	1,771	14,324	19,617	-	78,585	-	235	114,532	21.69
Lexington, . .	-	-	-	-	-	-	-	-	-	-	-	-	9,000	2,669	9,360	-	79,002	-	35,693	135,724	25.70
Nahant, . . .	-	-	-	-	-	-	-	-	-	-	-	-	150	11,550	4,800	-	36,800	-	55,200	108,500	20.55
Swampscott, . .	-	-	-	-	-	-	-	-	-	-	-	-	7,390	14,041	9,738	-	57,893	-	9,025	98,087	18.58
Total feet, .	26,652	221,836	24,888	23,104	95,151	126,618	244	139,323	162,176	367	354,019	48,160	1,625,756	584,592	1,283,769	994	3,225,513	948	680,102	8,624,212	-
Total miles, .	5.05	42.01	4.71	4.38	18.01	23.98	0.05	26.39	30.71	0.07	67.05	9.12	307.91	110.72	243.14	0.19	610.89	0.18	128.81	-	1,633.37

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[1] Includes small portion of Saugus.

TABLE NO. 41. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1910, and the Number of Services and Meters installed during the Year 1910.*

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.	Services Installed.	Meters Installed.
Boston, ...	93,780	18,720	8,406	1,134	6,615
Somerville, ...	12,149	5,810	1,065	149	728
Malden, ...	7,440	7,163	440	161	185
Chelsea, ...	4,790	3,082	346	105	884
Everett, ...	5,380	1,186	528	62	354
Quincy, ...	7,307	2,634	808	493	602
Medford, ...	4,550	4,296	545	149	1,704
Melrose, ...	3,583	3,777	320	79	270
Revere,[1]	3,454	891	183	188	295
Watertown, ...	2,042	2,070	341	69	97
Arlington, ...	2,050	1,288	398	83	167
Milton, ...	1,454	1,454	356	74	74
Winthrop, ...	2,487	2,386	207	167	873
Stoneham, ...	1,467	635	112	21	207
Belmont, ...	909	909	177	63	63
Lexington, ...	836	475	138	57	113
Nahant, ...	532	227	81	20	48
Swampscott, ...	1,478	1,465	142	82	110
Total, ...	156,688	58,468	14,593	3,156	13,389

[1] Includes small portion of Saugus.

TABLE No. 42. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, to which Water rose at Different Stations on the Metropolitan Water Works in 1910.*

1910.	LOW SERVICE.														SOUTHERN HIGH SERVICE.			
MONTH.	BOSTON ENGINE HOUSE, BULFINCH STREET.		ALLSTON ENGINE HOUSE, HARVARD STREET.		MEDFORD, MYSTIC RESERVOIR.		MEDFORD CITY HALL ANNEX, HIGH STREET.		SOMERVILLE CITY HALL ANNEX, WALNUT STREET.		MALDEN WATER WORKS SHOP, GREEN STREET.		CHELSEA COURT HOUSE.		BOSTON METROPOLITAN WATER WORKS OFFICE, 1 ASHBURTON PLACE.		WATERTOWN WATER WORKS OFFICE, MAIN STREET.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January, .	136	126	180	168	167	163	167	163	168	162	165	161	163	155	249	235	263	259
February, .	134	124	180	170	167	164	167	163	167	162	164	161	163	155	249	236	263	256
March, .	136	129	180	171	168	164	168	163	168	163	165	162	165	157	249	237	263	257
April, . .	141	126	178	170	168	165	168	163	167	163	165	161	166	158	249	236	263	257
May, . .	151	129	188	179	180	171	180	171	176	168	169	164	170	160	248	235	263	255
June, . .	149	129	181	172	168	164	168	163	167	161	165	161	166	156	248	235	263	255
July, . .	142	128	183	176	167	163	167	162	167	163	165	162	166	156	249	236	262	247
August, .	144	128	184	175	167	164	166	162	168	162	166	161	166	156	249	237	262	248
September, .	143	130	182	172	168	164	168	162	167	162	166	160	166	157	249	237	263	253
October, .	150	129	188	181	167	163	167	162	167	162	165	161	165	157	249	237	263	255
November, .	152	129	195	192	166	162	166	161	168	163	165	161	165	157	250	237	263	258
December, .	134	125	184	175	167	164	167	162	168	163	165	161	163	154	248	235	261	255
Averages, .	143	128	184	175	168	164	168	163	168	163	165	161	165	157	249	236	263	255

TABLE No. 42. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, etc.* — Concluded.

1910. MONTH.	SOUTHERN HIGH-SERVICE — Concluded.								NORTHERN HIGH-SERVICE.										NORTHERN EXTRA HIGH-SERVICE.	
	BELMONT WATER WORKS SHOP, WAVERLEY STREET.		MILTON WATER WORKS OFFICE, ADAMS STREET.		FORBES HILL TOWER, QUINCY.		QUINCY WATER WORKS SHOP.		SOMERVILLE PUMPING STATION, CEDAR STREET.		MALDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE, UNION SQUARE.		WINTHROP TOWN HALL, HERMAN STREET.		LEXINGTON TOWN HALL, MASSACHUSETTS AVENUE.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January, .	263	254	247	239	238	231	237	221	270	255	271	264	268	257	266	257	197	175	382	368
February, .	263	254	246	238	237	230	236	219	270	257	269	263	268	258	266	257	198	176	386	371
March, .	263	252	246	236	237	230	237	219	270	256	272	266	269	258	267	258	200	178	379	365
April, .	262	250	247	236	238	228	237	217	269	253	272	265	269	258	267	258	200	170	387	371
May, . .	262	249	246	234	236	226	235	215	270	250	271	263	268	254	267	252	206	177	387	368
June, . .	262	249	245	235	235	224	234	211	268	249	268	260	265	252	263	250	210	187	385	365
July, . .	262	238	246	231	234	219	232	200	268	240	268	258	261	244	254	227	203	178	380	351
August, .	262	241	245	234	235	222	232	204	267	249	267	259	260	246	255	235	193	176	386	362
September,	263	251	246	235	236	225	235	209	268	250	268	261	266	258	264	256	187	174	386	371
October, .	263	249	247	233	239	226	237	210	269	249	269	263	265	257	264	257	192	178	387	368
November,	263	251	248	233	238	230	238	211	270	253	271	266	267	259	266	259	194	182	386	369
December,	262	253	245	234	238	230	236	212	269	252	270	266	266	259	264	258	198	188	386	369
Averages,	263	249	246	235	237	227	236	212	269	251	270	263	266	255	264	252	198	178	385	367

APPENDIX No. 3.

WATER WORKS STATISTICS FOR THE YEAR 1910.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns: —

CITY OR TOWN.	Population, Census of 1910.	Estimated Population, July 1, 1910.
Boston,	670,585	674,400
Somerville,	77,236	77,640
Malden,	44,404	44,730
Chelsea,	32,452	32,540
Newton,[1]	39,806	39,960
Everett,	33,484	33,710
Quincy,	32,642	32,870
Medford,	23,150	23,330
Hyde Park,[1]	15,507	15,560
Melrose,	15,715	15,790
Revere,	18,219	18,500
Watertown,	12,875	12,960
Arlington,	11,187	11,270
Milton,	7,924	7,970
Winthrop,	10,132	10,290
Stoneham,	7,090	7,130
Swampscott,	6,204	6,260
Lexington,	4,918	4,940
Belmont,	5,542	5,600
Nahant,	1,184	1,200
Total population of Metropolitan Water District,	1,070,256	1,076,650
Saugus,[2]	280	280

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[1] No water supplied to these places during the year from Metropolitan Water Works.

[2] Only a small portion of Saugus is supplied with water.

Mode of Supply.

26 per cent. by gravity.
74 per cent. by pumping.

Pumping.

Chestnut Hill High-service Station: —

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used: — Bituminous: Beaver Run, Nan-ty-glo, and Vulcan. Anthracite: buckwheat. Price per gross ton in bins: bituminous $3.96 to $4.09, buckwheat $2.75 to $2.80. Average price per gross ton $3.70. Per cent. ashes, 11.0.

Chestnut Hill Low-service Station: —

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used: — Bituminous: Vulcan, Beaver Run. Anthracite: buckwheat. Price per gross ton in bins: bituminous $3.79 to $4.01, buckwheat $2.58 to $2.62. Average price per gross ton $3.46. Per cent. ashes, 10.6.

Spot Pond Station: —

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used: — Bituminous: Davis, Georges Creek and New River. Anthracite: screenings. Price per gross ton in bins: bituminous $4.60 to $4.88, screenings $2.50. Average price per gross ton $4.29. Per cent. ashes, 12.9.

	Chestnut Hill High-service Station.		
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000
Coal consumed for year (pounds),	2,168,024	247,119	8,467,877
Cost of pumping, figured on pumping station expenses,	$8,114.83	$1,014.59	$33,239.02
Total pumpage for year, corrected for slip (million gallons),	1,377.71	228.67	10,824.70
Average dynamic head (feet),	119.67	129.88	130.58
Gallons pumped per pound of coal,	635.47	925.34	1,278.33
Duty on basis of plunger displacement,	65,810,000	104,710,000	141,840,000
Cost per million gallons raised to reservoir,	$5.890	$4.437	$3.071
Cost per million gallons raised one foot,	.0492	.0342	.0235

	Chestnut Hill Low-service Station.	Spot Pond Station.
	Engines Nos. 5, 6 and 7.	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	105,000,000	30,000,000
Coal consumed for year (pounds),	7,122,390	2,413,914
Cost of pumping, figured on pumping station expenses,	$32,990.07	$13,622.47
Total pumpage for year, corrected for slip (million gallons),	18,394.52	2,752.11
Average dynamic head (feet),	49.08	130.92
Gallons pumped per pound of coal,	2,582.63	1,140.10
Duty on basis of plunger displacement,	107,750,000	126,860,000
Cost per million gallons raised to reservoir,	$1.793	$4.950
Cost per million gallons raised one foot,	.0365	.0378

Consumption.

Estimated total population of the nineteen cities and towns supplied wholly or partially during the year 1910,	1,022,230
Total consumption (gallons), pump basis,	41,539,100,000
Average daily consumption (gallons), pump basis,	113,806,000
Gallons per day to each inhabitant, pump basis,	111.3

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	–[1]	–[2]
Sizes,	60 to 6 inch.	60 to 4 inch.
Extensions, less length abandoned (miles),	4.49	30.75
Length in use (miles),	97.02	1,633.37
Stop gates added,	25	-
Stop gates now in use,	429	-
Service pipes added,	-	3,156
Service pipes now in use,	-	155,636
Meters added,	-	13,389
Meters now in use,	-	58,462
Fire hydrants added,	-	238
Fire hydrants now in use,	-	14,593

[1] Cast-iron and cement-lined wrought iron.

[2] Cast-iron, cement-lined wrought iron and kalamine.

APPENDIX NO. 4.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	68	Additions to the pumping plant at Deer Island, Boston Harbor.	4	$69,230 00[2]	$51,990 00	Allis-Chalmers Co., Milwaukee, Wis.
2	73	Additions to the pumping plant at East Boston.	1	-	37,000 00[2]	Allis-Chalmers Co., Milwaukee, Wis.
3	74	Extension and repair of engine, boiler and screen-houses and new coal house at East Boston.	6	123,722 00	110,940 00[2]	Woodbury & Leighton Co., Boston.
4	75[1]	2,950 tons of coal: — 2,500 tons for East Boston pumping station. 450 tons for Alewife Brook pumping station.	 6 3	 $3.96 per ton. $4.30 per ton.	 $3.69 per ton.[2] $4.25 per ton.[2]	New England Coal and Coke Co., Boston.
5	76[1]	3,050 tons of coal: — 2,100 tons for Deer Island pumping station. 950 tons for Charlestown pumping station.	 7 6	 $3.85 per ton. $3.65 per ton.	 $3.74 per ton.[2] $3.64 per ton.[2]	Staples Coal Co., Boston.
6	78[1]	Additions to the boiler plant at East Boston pumping station.	6	$31,933 00[2]	$29,000 00	Robb-Mumford Boiler Co., South Framingham.
7	79[1]	Two sets of screens for the Deer Island pumping station.	2	5,994 00	5,600 00[2]	Hyde Windlass Co., Bath, Me.
8	80[1]	Pile wharf, steel floor beams, braces and coal runs at the East Boston pumping station.	8	9,498 00	8,475 00[2]	John T. Scully Foundation and Transportation Company, Cambridge.
9	82	4,400 tons of coal: — 3,000 tons for East Boston pumping station. 1,000 tons for Charlestown pumping station. 400 tons for Alewife Brook pumping station.	 6 3 2	 $4.12 per ton. $4.09 per ton. $4.85 per ton.	 $4.10 per ton.[2] $3.90 per ton.[2] $4.55 per ton.[2]	New England Coal and Coke Co., Boston.
10	83	2,600 tons of coal for Deer Island pumping station.	3	$4.22 per ton.	$4.20 per ton.[2]	Metropolitan Coal Co., Boston.

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[1] Contract completed.

[2] Contract based upon this bid.

APPENDIX No. 4.

THE YEAR 1910 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1910.	10. Value of Work done Dec. 31, 1910.	
Nov. 2, 1908	-	- -	$62,307 00	1
June 5, 1909	-	- -	18,500 00	2
Aug. 13, 1909	-	- -	114,934 71[1]	3
June 18, 1909	June 1, 1910	- -	11,662 77	4
June 25, 1909	June 1, 1910	- -	12,442 46	5
Dec. 15, 1909	Dec. 12, 1910	- -	31,933 00	6
May 16, 1910	Aug. 20, 1910	For furnishing and delivering two sets of screens for the Deer Island pumping station on the Deer Island wharf in condition for erection.	5,600 00	7
July 15, 1910	Dec. 23, 1910	For furnishing and erecting pile wharf, steel floor beams, braces and coal runs for the East Boston pumping station.	8,618 91	8
July 25, 1910	-	$4.10 per ton of 2,240 lbs. delivered in bins at East Boston pumping station. $3.90 per ton of 2,240 lbs. delivered in bins at Charlestown pumping station. $4.55 per ton of 2,240 lbs. delivered in bins at Alewife Brook pumping station.	9,445 84	9
July 25, 1910	-	$4.20 per ton of 2,240 lbs. delivered in bins at Deer Island pumping station.	6,238 92	10

[1] $17,284.43 charged to special maintenance fund.

CONTRACTS MADE AND PENDING DURING THE

Contracts relating to the South

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	76[1]	2,500 tons of coal: — 2,100 tons for Ward Street pumping station. 400 tons for Nut Island screen-house.	6 7	$4.14 per ton. $4.10 per ton.	$4.09 per ton.[2] $3.74 per ton.[2]	Staples Coal Co., Boston.
2	77[1]	400 tons of coal for Quincy pumping station.	3	$4.40 per ton.	$4.15 per ton.[2]	Neponset River Coal Co., Dorchester.
3	83	500 tons of coal for Nut Island screen-house.	4	$4.24 per ton.	$4.20 per ton.[2]	Metropolitan Coal Co., Boston.
4	84	2,300 tons of coal for Ward Street pumping station.	3	$4.45 per ton.	$4.29 per ton.[2]	Staples Coal Co., Boston.
5	85	400 tons of coal for Quincy pumping station.	3	$4.80 per ton.	$4.50 per ton.[2]	Frost Coal Co., Dorchester.
6	87	Receiving basin, foundations and appurtenances for sewage lift station, Hough's Neck, Quincy.	8	$10,800 00	$9,371 00[2]	John Cashman & Sons Company, Quincy.
7	88	Sewage lift station building, Hough's Neck, Quincy.	6	1,760 00	1,725 00[2]	C. A. Dodge Company, Cambridge.

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[1] Contract completed.

[2] Contract based upon this bid.

YEAR 1910 — SEWERAGE WORKS — *Continued.*

Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1910.	10. Value of Work done Dec. 31, 1910.	
June 25, 1909	June 1, 1910	- -	$8,756 01	1
June 30, 1909	June 1, 1910	- -	1,531 01	2
July 25, 1910	-	$4.20 per ton of 2,240 lbs. delivered in bins at Nut Island screen-house.	810 00	3
July 25, 1910	-	$4.29 per ton of 2,240 lbs. delivered in bins at Ward Street pumping station.	1,713 17	4
July 25, 1910	-	$4.50 per ton of 2,240 lbs. delivered in bins at Quincy pumping station.	299 19	5
Aug. 29, 1910	-	For earth excavation and refilling in receiving basin, pump well, pipe and conduit trenches and grading lot, including manholes, laying of pipe, etc., the sum of $2,271; for Portland cement brick masonry in manholes, $16 per cu. yd.; for Portland cement concrete masonry, $9 per cu. yd.	3,465 50	6
Nov. 14, 1910	-	For brick sewage lift station building, . . .	-	7

CONTRACTS MADE AND PENDING DURING THE YEAR 1910 — SEWERAGE WORKS — *Concluded.*

Summary of Contracts.[1]

	Value of Work done Dec. 31, 1910.
North Metropolitan System, 10 contracts,	$281,683 61
South Metropolitan System, 7 contracts,	16,574 88
Total of 17 contracts made and pending during the year 1910,	$298,258 49

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[1] In this summary the cost of day work and contracts charged to maintenance are excluded.

APPENDIX NO. 5.

FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT ON JANUARY 9, 1911.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the year ending November 30, 1910, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

METROPOLITAN WATER WORKS.

Construction.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1910, have been as follows: —

Loans authorized under Metropolitan Water acts,		$41,878,000 00
Receipt from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320),		90,000 00
Receipts from the sales of property which are placed to the credit of the Metropolitan Water Loan Fund: —		
For the year ending November 30, 1910,	$8,727 94	
For the period prior to December 1, 1909,	167,051 56	
		175,779 50
		$42,143,779 50
Amount approved for payment by the Board out of the Metropolitan Water Loan Fund: —		
For the year ending November 30, 1910,	$478,791 51	
For the period prior to December 1, 1909,	41,000,955 40	
		41,479,746 91
Balance December 1, 1910,		$664,032 59

The amount of the Metropolitan Water Loan bonds issued and outstanding at the beginning of the fiscal year was $40,898,000. At the end of the year the amount of the loans was $41,398,000. The Metropolitan Water Loan Sinking Fund amounted at the beginning of the year to $7,203,406.48, and at the end of the year to $8,070,383.46. The net decrease in the debt for the Metropolitan Water Works was $366,976.98.

Maintenance.

Amount appropriated for the maintenance and operation of works for the year ending November 30, 1910,	$414,000 00	
Balance of special appropriation for the improvement of the Cochituate watershed (1909), remaining,	29,576 10	
Amount appropriated for the improvement of the Cochituate watershed, additional,	6,000 00	
		$449,576 10
Amount approved by the Board for maintenance and operation of works during year ending November 30, 1910,		408,706 35
Balance December 1, 1910,		$40,869 75

This balance includes the sum of $13,307.38 appropriated for the improvement of the Cochituate watershed, which sum remains for the completion of the improvement.

The Board has also received during the year ending November 30, 1910, $13,620.20 from rentals, land products and other proceeds from the operations of the Board which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, thus reducing the amount of the assessment upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows: —

For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act,	$219,865 65
For the period beginning December 1, 1906, and prior to December 1, 1909, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907,	16,851 21
For the year beginning December 1, 1909, and ending November 30, 1910, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act,	3,798 14
	$240,515 00

METROPOLITAN SEWERAGE WORKS.

Construction.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows: —

NORTH METROPOLITAN SYSTEM.

Loans authorized for expenditures for construction under the various acts, including those for the Revere, Belmont and Malden extensions and North System enlargement and extension,	$6,573,865 73	
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System: —		
For the year ending November 30, 1910,	123 99	
For the period prior to December 1, 1909,	46,307 18	
Amount approved for payment by the Board [1] out of the Metropolitan Sewerage Loan Fund, North System: —		
For the year ending November 30, 1910,		$194,897 44
For the period prior to December 1, 1909,		6,303,340 50
	$6,620,296 90	$6,498,237 94
Balance December 1, 1910,		$122,058 96

SOUTH METROPOLITAN SYSTEM.

Loans authorized for expenditures for construction under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension,	$8,867,046 27	
Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —		
For the year ending November 30, 1910,	-	
For the period prior to December 1, 1909,	11,406 82	
Amount approved by the Board for payment as follows: —		
On account of the Charles River valley sewer,		$800,046 27
On account of the Neponset valley sewer,		911,531 46
On account of the High-level sewer and extension: —		
For the year ending November 30, 1910,		8,570 75
For the period prior to December 1, 1909,		7,071,931 65
	$8,878,453 09	$8,792,080 13
Balance December 1, 1910,		$86,372 96

The loans for the Metropolitan Sewerage Works outstanding at the beginning of the fiscal year amounted to $15,327,912, and at the end of the year to $15,440,912. The amount of the Metropolitan Sewerage Sinking Fund was at the beginning of the fiscal year $1,672,017.97, and at the end of the year was $1,929,528.07. The net decrease in the debt for the Metropolitan Sewerage Works was $144,510.10.

Maintenance.

NORTH METROPOLITAN SYSTEM.

Appropriated for the year ending November 30, 1910,	$149,000 00
Balance of special appropriation for the restoration and equipment of the East Boston pumping station (1908), remaining,	13,884 43
Receipts from pumping and from other sources, which are returned to the appropriation: —	
For the year ending November 30, 1910,	3,062 79
	$165,947 22
Amount approved for payment by the Board: —	
For the year ending November 30, 1910,	159,889 34
Balance December 1, 1910,	$6,057 88

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[1] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

This balance of $6,057.88 includes the sum of $849.43 which still remains out of the special appropriation for the restoration and equipment of the East Boston pumping station, which have not yet been completed. The general balance remaining is consequently $5,208.45.

South Metropolitan System.

Appropriated for the year ending November 30, 1910,	$103,200 00
Receipts from sales of property and for pumping, which are returned to the appropriation: —	
For the year ending November 30, 1910,	87 65
	$103,287 65
Amount approved for payment by the Board: —	
For the year ending November 30, 1910,	100,832 60
Balance December 1, 1910,	$2,455 05

APPENDIX NO. 6.

LEGISLATION OF THE YEAR 1910 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

ACTS OF 1910.

[CHAPTER 32.]

AN ACT RELATIVE TO CERTAIN AUTHORIZED ADDITIONS TO THE METROPOLITAN WATER LOAN.

Be it enacted, etc., as follows:

1909, 320, § 2, amended.

SECTION 1. Section two of chapter three hundred and twenty of the acts of the year nineteen hundred and nine, being "An Act to authorize the metropolitan water and sewerage board to make certain improvements in the metropolitan water system", is hereby amended by striking out the words and figures "Act of 1909", in the thirteenth line.

SECTION 2. This act shall take effect upon its passage. [*Approved January 31, 1910.*

[CHAPTER 220.]

AN ACT TO PROVIDE FOR SUPERVISION BY THE GOVERNOR AND COUNCIL OF EXPENDITURES AND OTHER FINANCIAL OPERATIONS OF THE COMMONWEALTH.

Be it enacted, etc., as follows:

Requests for annual appropriations to be submitted to auditor and transmitted to governor and council.

SECTION 1. Every officer or board having charge of any department, institution or undertaking which receives an annual appropriation of money from the treasury of the commonwealth, including annual appropriations to be met by assessments, shall, annually, on or before the fifteenth day of November, submit to the auditor of the commonwealth statements in detail showing the amount appropriated for the current fiscal year and the amounts required for the ensuing fiscal year, with an explanation of the reason for any increased appropriation, and with citations of the statutes relating thereto, and with a statement of the expenditures for the current year and for each of the next preceding two years. The said estimates shall not include any estimates for special purposes or objects. The auditor of the commonwealth shall embody the said statements, with a like statement relating to his own department, in one document, which shall be printed, and shall be submitted on or before the first Thursday in January of each year to the governor and council for examination, and the governor shall transmit the same to the general court with such recommendations, if any, as he may deem proper. The auditor shall also submit his estimates for the ensuing fiscal year for the ordinary and other revenue of the commonwealth which shall be made a part of the document herein provided for. Copies of the document shall be distributed to the members of the general court.

Requests for special appropriations to be submitted to auditor and transmitted to governor and council.

SECTION 2. Officers, heads of departments, boards, commissions and trustees of institutions, who, in their annual reports, or otherwise, recommend appropriations from the state treasury for special purposes or objects, including appropriations to be met by assessments, in addition to the ordinary running expenses, shall submit estimates thereof in detail to the auditor of the commonwealth on or before the fifteenth day of November in each year, and he shall classify them and embody them in one document which shall be printed, and shall be submitted on or before the first Thursday in January of each year to the governor and council for examination, and the governor shall transmit the same to the general court with such recommendations, if any, as he may deem proper. He shall make recommendation as to how much should be raised by the issue of bonds and how much should be paid out of current revenue. Copies of the document shall be distributed to the members of the general court.

Plans, estimates, etc., to be submitted to governor and council.

SECTION 3. The plans, estimates and specifications made in accordance with the provisions of chapter five hundred and twenty of the acts of the year nineteen hundred and seven, or of amendments thereof, relating to any improvement described in either of the documents aforesaid, shall at the same time be submitted to the governor and council.

Further information to be furnished by auditor.

SECTION 4. The auditor shall furnish to the governor and council such further information in regard to the revenue, expenditures and other financial operations of the commonwealth, and in such form as the governor may require.

Recommendations of the governor to general court.

SECTION 5. The governor may, in his discretion, transmit to the general court from time to time, with his recommendations, if any, thereon, particular items in either of the said documents, and may withhold other items for further investigation.

Repeal.

SECTION 6. Section twenty-six of chapter six of the Revised Laws, as amended by section six of chapter two hundred and eleven of the acts of the year nineteen hundred and five and section five of chapter five hundred and ninety-seven of the acts of the year nineteen hundred and eight, and all acts and parts of acts inconsistent herewith, are hereby repealed.

SECTION 7. This act shall take effect upon its passage. [*Approved March 16, 1910.*

[CHAPTER 268.]

AN ACT TO PROVIDE FOR THE ANNUAL PREPARATION AND PRINTING OF LISTS OF STATE OFFICIALS AND EMPLOYEES WITH THEIR SALARIES OR COMPENSATION.

Be it enacted, etc., as follows:

Lists of officials and employees of the commonwealth to be furnished to the governor and council, etc.

SECTION 1. Every department, commission, bureau or board of the commonwealth, shall, on or before the fifteenth day of July in the year nineteen hundred and ten, and on or before the fifteenth day of July in every year thereafter, prepare and furnish to the governor and council lists of all the officials and employees of the commonwealth employed in or by such department, commission, bureau or board on the first day of July preceding, for whose services money has been paid from the treasury of the commonwealth. The said lists shall be arranged by divisions of the several departments, commissions, bureaus or boards, when such divisions exist, and shall give the name, residence, designation, rate of compensation and the date of election or appointment of every such official and employee, and any increase in the rate of salary or compensation for the year preceding; and also the aggregate amount of all money paid for services or salaries to any official or employee, not otherwise shown upon the list, for the year beginning with the first day of July in the year

Auditor to verify lists, etc.

preceding that in which the list is prepared. It shall be the duty of the auditor of the commonwealth to verify the said lists, the compensation and the said aggregate amounts from the pay roll. The said lists and aggregate amounts shall be printed at the expense of the commonwealth as a document of the commonwealth, before the first day of October in the year in which they are furnished, and the said document shall contain the complete data and facts called for by this act.

SECTION 2. This act shall take effect upon its passage. [*Approved March 22, 1910.*

[CHAPTER 291.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO MAKE CERTAIN IMPROVEMENTS IN THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Appropriations for construction for certain purposes in metropolitan water district.

SECTION 1. The sum of one hundred and five thousand dollars shall be allowed and paid out of the treasury of the commonwealth from the Metropolitan Water Loan Fund for the following purposes: — For a thirty-six inch main for the improvement of the supply of the East Boston district of the city of Boston; and for a new main for the extension of the high-service district in Arlington and Lexington.

Issue of bonds authorized.

SECTION 2. For the purposes aforesaid the metropolitan water and sewerage board may, in addition to providing for the improvements for which expenditures have hitherto been authorized, expend any sum heretofore appropriated for the construction of the metropolitan water works. To meet the further expenditures incurred under the provisions of this act, and not so provided for, the treasurer and receiver general shall, from time to time, issue upon the request of said board, bonds in the name and behalf of the commonwealth, to be designated on the face thereof, Metropolitan Water Loan, to an amount not exceeding eighty thousand dollars, in addition to the sum of forty-one million seven hundred and ninety-eight thousand dollars authorized to be issued by chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and acts in addition thereto, and the provisions of said chapter four hundred and eighty-eight and acts in amendment thereof and in addition thereto shall apply to this additional loan.

SECTION 3. This act shall take effect upon its passage. [*Approved March 25, 1910.*

[CHAPTER 292.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO ENABLE THE CITY OF QUINCY TO DRAIN ITS TERRITORY INTO THE HIGH-LEVEL SEWER.

Be it enacted, etc., as follows:

The city of Quincy may drain its territory into the high-level sewer.

SECTION 1. The metropolitan water and sewerage board is hereby authorized to expend from the balance remaining of the Metropolitan Sewerage Loan Fund, South System, such sum as may be required in compliance with section eight of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine for the construction of such works as may be necessary in order to enable the city of Quincy to drain by gravity its territory into the high-level sewer.

SECTION 2. This act shall take effect upon its passage. [*Approved March 25, 1910.*

[CHAPTER 340.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE SOUTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

Appropriation for maintenance of south metropolitan sewerage system.

SECTION 1. A sum not exceeding one hundred and three thousand two hundred dollars is hereby appropriated, to be paid out of the South Metropolitan System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan system of sewage disposal, comprising a part of Boston, the cities of Newton and Waltham, and the towns of Brookline, Watertown, Dedham, Hyde Park and Milton, during the fiscal year ending on the thirtieth day of November, nineteen hundred and ten.

SECTION 2. This act shall take effect upon its passage. [*Approved April 2, 1910.*

[CHAPTER 341.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Appropriation for maintenance of metropolitan water works.

SECTION 1. A sum not exceeding four hundred and twenty thousand dollars is hereby appropriated, to be paid out of the Metropolitan Water Maintenance Fund, for the maintenance and operation of the metropolitan water system for the cities and towns in what is known as the metropolitan water district, during the fiscal year ending on the thirtieth day of November, nineteen hundred and ten.

SECTION 2. This act shall take effect upon its passage. [*Approved April 2, 1910.*

[CHAPTER 359.]

AN ACT RELATIVE TO APPOINTMENT AND EMPLOYMENT IN THE PUBLIC SERVICE IN VIOLATION OF THE CIVIL SERVICE LAW OR RULES.

Be it enacted, etc., as follows:

R. L. 19, § 34, amended.

Enforcement of civil service rules.

Chapter nineteen of the Revised Laws is hereby amended by striking out section thirty-four and inserting in place thereof the following: — *Section 34.* If, in the opinion of the civil service commission, a person is appointed or employed in the public service classified under civil service rules, in violation of the civil service law, or of the said rules, the commission shall, after written notice mailed to the appointing or employing officer or officers, and to such person, notify in writing the treasurer, auditor or other disbursing officer of the commonwealth, city or town, in whose service or by which such person is so employed or paid; and the payment of any salary or compensation to such person shall be illegal and shall cease at the expiration of one week after the mailing of the latter notice, and until the legality of such appointment or employment is duly established. It shall be unlawful for the treasurer, auditor or other disbursing officer of the commonwealth, or of such city or town to draw, sign or issue, or to authorize the drawing, signing or issuing of any warrant, or to make payment of any salary or compensation to the person so found by the civil service commission to be illegally appointed or employed. Any person so found by the civil service commission to be illegally appointed or employed may file a petition for a writ of mandamus in the superior or supreme judicial court to compel the civil service commission to authorize such appointment, or employment, and the payment of compensation or salary therefor. At any time after the filing of such petition the court, if it is of opinion that there is reasonable doubt whether the appointment or employment of such person is in violation of the civil service law or rules, may order that the compensation accruing to such person shall be paid to him until otherwise ordered by said court. [*Approved April 8, 1910.*

Petition for writ of mandamus may be filed, etc.

[CHAPTER 388.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE NORTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

Appropriation for maintenance of north metropolitan sewerage system.

SECTION 1. A sum not exceeding one hundred and forty-nine thousand dollars is hereby appropriated, to be paid out of the North Metropolitan System Maintenance Fund, for the maintenance and operation of the system of sewage disposal for the cities included in what is known as the north metropolitan system, during the fiscal year ending on the thirtieth day of November, nineteen hundred and ten.

SECTION 2. This act shall take effect upon its passage. [*Approved April 13, 1910.*

[CHAPTER 452.]

AN ACT RELATIVE TO THE RECOMMENDATIONS FOR LEGISLATION IN THE ANNUAL REPORTS OF STATE BOARDS AND COMMISSIONS.

Be it enacted, etc., as follows:

R. L. 18, § 6, amended.

SECTION 1. Section six of chapter eighteen of the Revised Laws is hereby amended by inserting after the word "action", in the sixth line, the words: — such recommendations or suggestions to be accompanied by drafts of bills

Recommendations for legislation, etc.

embodying the legislation recommended, — so as to read as follows: — *Section 6.* State boards and commissions shall annually, on or before the first Wednesday in January, deposit with the secretary of the commonwealth such parts of their annual reports which are required to be made to the governor and council or to the general court as contain recommendations or suggestions for legislative action, such recommendations or suggestions to be accompanied by drafts of bills embodying the legislation recommended; and the secretary shall forthwith transmit them to the governor and council or to the general court.

SECTION 2. This act shall take effect upon its passage. [*Approved April 27, 1910.*

[CHAPTER 500.]

AN ACT RELATIVE TO HEARINGS GIVEN TO VETERANS IN THE PUBLIC SERVICE.

Be it enacted, etc., as follows:

R. L. 19, § 23, etc., amended.

Veterans not to be removed without a hearing, etc.

SECTION 1. Section twenty-three of chapter nineteen of the Revised Laws, as amended by chapter one hundred and fifty of the acts of the year nineteen hundred and five, is hereby further amended by striking out the said section and inserting in place thereof the following: — *Section 23.* No veteran who holds an office or employment in the public service of the commonwealth or of any city or town therein, shall be removed or suspended, or shall, without his consent, be transferred from such office or employment, nor shall his office be abolished, nor shall he be lowered in rank or compensation, except after a full hearing of which he shall have at least seventy-two hours' written notice, with a statement of the reasons for the contemplated removal, suspension, transfer, lowering in rank or compensation, or abolition. The hearing shall be before the state board of conciliation and arbitration, if the veteran is a state employee, and before the selectmen of the town of which he is an employee, if the veteran is a town employee. If the veteran is a city employee the hearing shall be held before the board of aldermen of the city of which the veteran is an employee. In case the city of which the veteran is an employee has not a board of aldermen, the hearing shall be held before the city council of such city. At any hearing where the veteran is a party in interest, he shall have the right to be present and to be represented by counsel. The said removal, suspension or transfer, lowering in rank or compensation, or abolition of an office, shall be made only upon a written order stating fully and specifically the cause or causes therefor, and signed by the state board of conciliation and arbitration, or selectmen, or said members of the city government, as the case may be, after a hearing as aforesaid.

SECTION 2. This act shall take effect upon its passage.

(The foregoing was laid before the Governor on the third day of May, 1910, and after five days it had " the force of a law ", as prescribed by the Constitution, as it was not returned by him with his objections thereto within that time.)

[CHAPTER 515.]

AN ACT RELATIVE TO THE TAXATION OF PROPERTY HELD BY THE METROPOLITAN WATER AND SEWERAGE BOARD IN THE TOWN OF CLINTON AND TO THE SALE OR DISPOSAL OF ELECTRICITY BY SAID BOARD.

Be it enacted, etc., as follows:

Taxation of property held by metropolitan water and sewerage board in town of Clinton.

SECTION 1. The property held by the metropolitan water and sewerage board, or its successors, in the town of Clinton which may be subject to taxation under the provisions of section two of chapter four hundred and ninety-eight of the acts of the year nineteen hundred and six shall be assessed on a valuation of one hundred and twenty-five thousand dollars in any year in which any power is generated and sold.

Sale or disposal of electricity.

SECTION 2. In the sale or disposal of electricity generated in the town of Clinton for power or manufacturing purposes under the provisions of section three of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, preference shall be given to persons or corporations proposing to use all of such electricity in the town of Clinton: *provided*, that there are responsible persons or corporations so proposing to use all the electricity in said town who shall offer to purchase the same on terms as advantageous as shall be offered by others not so proposing to use the same; and the said board shall, at least ten days before making a contract for the sale of such electricity, cause to be printed in some newspaper published in said town a request for pro-

Proviso.

posals for the purchase of the electricity to be generated and sold by said board.

SECTION 3. This act shall take effect upon its passage. [*Approved May 13, 1910.*

[CHAPTER 546.]

AN ACT TO PROVIDE FOR THE ADDITION OF THE TOWN OF BRAINTREE TO THE SOUTH METROPOLITAN SEWERAGE SYSTEM.

Be it enacted, etc., as follows:

Town of Braintree added to the south metropolitan sewerage district.

SECTION 1. The territory comprising the town of Braintree is hereby added to the south metropolitan sewerage district, created by chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine. In becoming a part of the said system said town shall be subject to the provisions and shall conform to the requirements of said act and acts in amendment thereof and in addition thereto, except as is otherwise provided herein. Any authority granted to other municipalities by said act or acts in amendment thereof and in addition thereto is also vested in the town of Braintree, in common with such other municipalities.

Outlet to be provided at the Braintree town line, etc.

SECTION 2. The metropolitan water and sewerage board shall provide an outlet at the Braintree town line for the sewerage of said town, and, acting on behalf of the commonwealth, shall construct a main trunk sewer or sewers through such parts of the city of Quincy to such point in the south metropolitan system as said board may determine to be necessary in order to make connection with the high-level sewer.

The metropolitan water and sewerage board to exercise certain authority, etc.

SECTION 3. In providing for such outlet and in receiving sewage from the town of Braintree, and in any action relating thereto, and for the purpose of taking, constructing and maintaining such additional main lines of sewers, the said metropolitan water and sewerage board, acting on behalf of the commonwealth, shall have and exercise all the authority conferred upon it by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and by chapter one hundred and sixty-eight of the acts of the year nineteen hundred and one, and by acts in amendment thereof and in addition thereto; and all the provisions of said acts are made applicable to the additional construction, maintenance and operation hereby authorized except as otherwise provided herein.

Metropolitan Sewerage Loan.

SECTION 4. To meet the expenses incurred under the provisions of this act, the treasurer of the commonwealth shall from time to time issue in the name and behalf of the commonwealth and under its seal bonds designated on the face thereof, Metropolitan Sewerage Loan, for a term not exceeding thirty years, to an amount not exceeding one hundred thousand dollars in addition to the amount of such bonds heretofore authorized for the construction of the south metropolitan sewerage works. The provisions of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine and all acts in amendment thereof and in addition thereto shall, so far as they are applicable, apply to the indebtedness authorized by this act.

Certain provisions of law to apply.

Payment of loans, etc.

SECTION 5. The interest and sinking fund requirements on account of the moneys expended in constructing that part of the sewerage system provided for in this act, and the cost of maintenance and operation thereof, shall be deemed and paid as a part of the interest, sinking fund requirements and costs specified in said chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine and acts in amendment thereof and in addition thereto, and shall be apportioned, assessed and collected in the manner provided by that chapter and acts in amendment thereof and in addition thereto except as is otherwise provided herein. The town of Braintree shall, in addition to the yearly payment of the assessment so provided for, pay into the treasury of the commonwealth for the sinking fund of the south metropolitan sewerage district such proportion of the total amount of said sinking fund, as existing on the first day of May in the year of its admission to the south metropolitan district, as the valuation of the said town for the said year shall bear to the total amount of the valuation of said district, as determined for the purposes of apportionment of assessments; and the town shall also pay the further sum of one thousand dollars. Such proportion shall be determined by the metropolitan water and sewerage board and shall be certified by said board to the treasurer of the commonwealth. The treasurer shall determine the total amount so to be paid by said town on account of its admission to the district, and for the payment thereof shall add one fifth of said total amount to the yearly sum payable by said town on account of its share of the interest and sinking fund requirements of the district for the succeeding five years. No assessment on account of maintenance requirements of the south metropolitan sewerage district shall be made upon said town until the calendar year in which its sewers shall be connected with the south metropolitan system as herein provided.

Time of taking effect.

SECTION 6. This act shall take effect when accepted by vote of the majority of the legal voters of the town of Braintree present and voting thereon at a meeting legally called for the purpose. [*Approved May 23, 1910.*

[CHAPTER 547.]

AN ACT TO PROVIDE FOR AN OUTLET FOR THE SEWAGE OF THE CITIES OF MALDEN AND EVERETT INTO THE NORTH METROPOLITAN SEWERAGE SYSTEM.

Be it enacted, etc., as follows:

Additional outlet for the sewage of Malden and Everett to be provided.

SECTION 1. The metropolitan water and sewerage board may, in order to provide an additional outlet for the sewage of the cities of Malden and Everett, acting in behalf of the commonwealth, take, or acquire by purchase or otherwise, the existing sewer belonging to the city of Malden from a point at or near the corner of Eastern avenue and Bryant street in said city and running northerly through Eastern avenue to a point at or near the middle of Broadway; and the said board is hereby authorized to pay to the city of Malden the actual cost of the construction of the portion of the sewer so taken, less such assessments as have been collected prior to the date of such taking. The said portion of the sewer when so taken shall become a part of the north metropolitan system of sewers. Upon acquiring the portion of the sewer in Eastern avenue as aforesaid the said board shall proceed to construct a sewer extending from said sewer through Broadway to a point at or near the boundary line between the cities of Malden and Everett, and the sewer so constructed shall become a part of the north metropolitan system. The city of Everett may, under the direction of said board, connect its local system of sewers with said metropolitan sewer in Broadway. The city of Malden may, under the direction of said board, connect its local system of sewers with the said metropolitan sewers in Broadway and Eastern avenue and may also, subject to such direction, make and maintain house connections with the said sewer. The city of Malden shall make assessments of annual rates for said metropolitan sewers in Broadway and Eastern avenue in the same manner in which such assessments are now made in said city for its local sewers. All such sums as may be assessed therefor shall be paid by the treasurer of said city into the treasury of the commonwealth, except such assessments as may be collected upon the portion of said sewer in Eastern avenue between Faulkner and Bryant streets, and shall be credited to and become a part of the Metropolitan Sewerage Loan Fund authorized by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and acts in amendment thereof and in addition thereto.

The metropolitan water and sewerage board to exercise certain authority, etc.

SECTION 2. For the purpose of taking and constructing said metropolitan sewers in Eastern avenue and Broadway and for the operation and maintenance thereof, the said board, acting in behalf of the commonwealth, shall have and exercise all the authority conferred upon it by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and all acts in amendment thereof and in addition thereto, and all the provisions of said acts are made applicable to the taking, construction, maintenance and operation of said sewers except as is otherwise provided herein.

Metropolitan Sewerage Loan.

SECTION 3. To meet the expenses incurred under the provisions of this act the treasurer and receiver general shall, from time to time, issue in the name and behalf of the commonwealth and under its seal bonds designated on the face thereof Metropolitan Sewerage Loan, for a term not exceeding thirty years, to an amount not exceeding fifty-six thousand dollars, in addition to the amount of such bonds heretofore authorized for the construction of the north metropolitan sewerage works. The provisions of chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-eight and

Certain provisions of law to apply.

all acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to the indebtedness authorized by this act.

Payment of loans, etc.

SECTION 4. The treasurer and receiver general shall, in addition to levying the assessments now required by law to meet the interest and sinking fund requirements of the north metropolitan system, assess annually upon the cities of Malden and Everett, in equal shares, such sums as may be necessary to satisfy the interest and sinking fund requirements of the bonds issued under the provisions of this act.

SECTION 5. This act shall take effect upon its passage. [*Approved May 23, 1910.*

[CHAPTER 550.]

AN ACT RELATIVE TO THE POLLUTION OF CERTAIN SOURCES OF WATER SUPPLY.

Be it enacted, etc., as follows:

R. L. 75, § 123, amended.

Section one hundred and twenty-three of chapter seventy-five of the Revised Laws is hereby amended by striking out the said section and inserting in place thereof the following: — *Section 123.* The provisions of the preceding eleven sections shall not apply to the Connecticut river. The provisions of the preceding five sections and of so much of sections one hundred and twelve to one hundred and seventeen, inclusive, as refers to domestic water supplies shall not apply to the Merrimac river, nor to so much of the Concord river as lies within the limits of the city of Lowell, nor to springs, streams, ponds or water courses over which the metropolitan water and sewerage board has control. [*Approved May 23, 1910.*

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